POWER PLANT ENGINEERING

GENERATION - TRANSMISSION - DISTRIBUTION - UTILIZATION

Contents

Crystal Gazing 1933 500

With the Editors 501

Parades past the Power Plant. Preparation Time. Possibilities of Increasing Load Offered by Electrochemistry.

The March of Progress Across the Power Plant Stage 502

The Economics of Power Generation. By Geo. A. Orrok 508

The Central Station and the Industrial Plant: Must They Compete, or Can They Work Together for the Common Good?

10,000 B.t.u. per kw-hour No Longer an Idle Dream 512

Mercury Vapor. High Temperature and High Pressure Bring Heat Rate Figures Close to the Ideal for Present Heat Cycles.

The Years' Development in Steam Generating Equipment 515

Prime Movers Improved by Perfection of Details 520

Hydraulic Power Practice in 1933 523

Application of New Principles Marks Electrical Development 526

Application of New Principles Cause Renewed Development in Many Branches of the Electrical Art.

A. S. M. E. Papers at N. Y. Meeting Reflect Technical Progress in Engineering 532

Research Opens the Door to Progress 538

Ideas Taken from the Laboratory and Developed in the Experimental Plant Have Contributed Greatly to Economy and Safety.

Lunkenheimer Oil Controller. High Pressure Needle Valves. Air Separation Pulverizer. Roller Bearings. Multiple Seat Union 541

New Trap Line 542

News from the Field 542

For the Engineer's Library 542

Power Plant Construction News 544

Contents of back issues of Power Plant Engineering will be found in Industrial Arts Index on file in Public Libraries.

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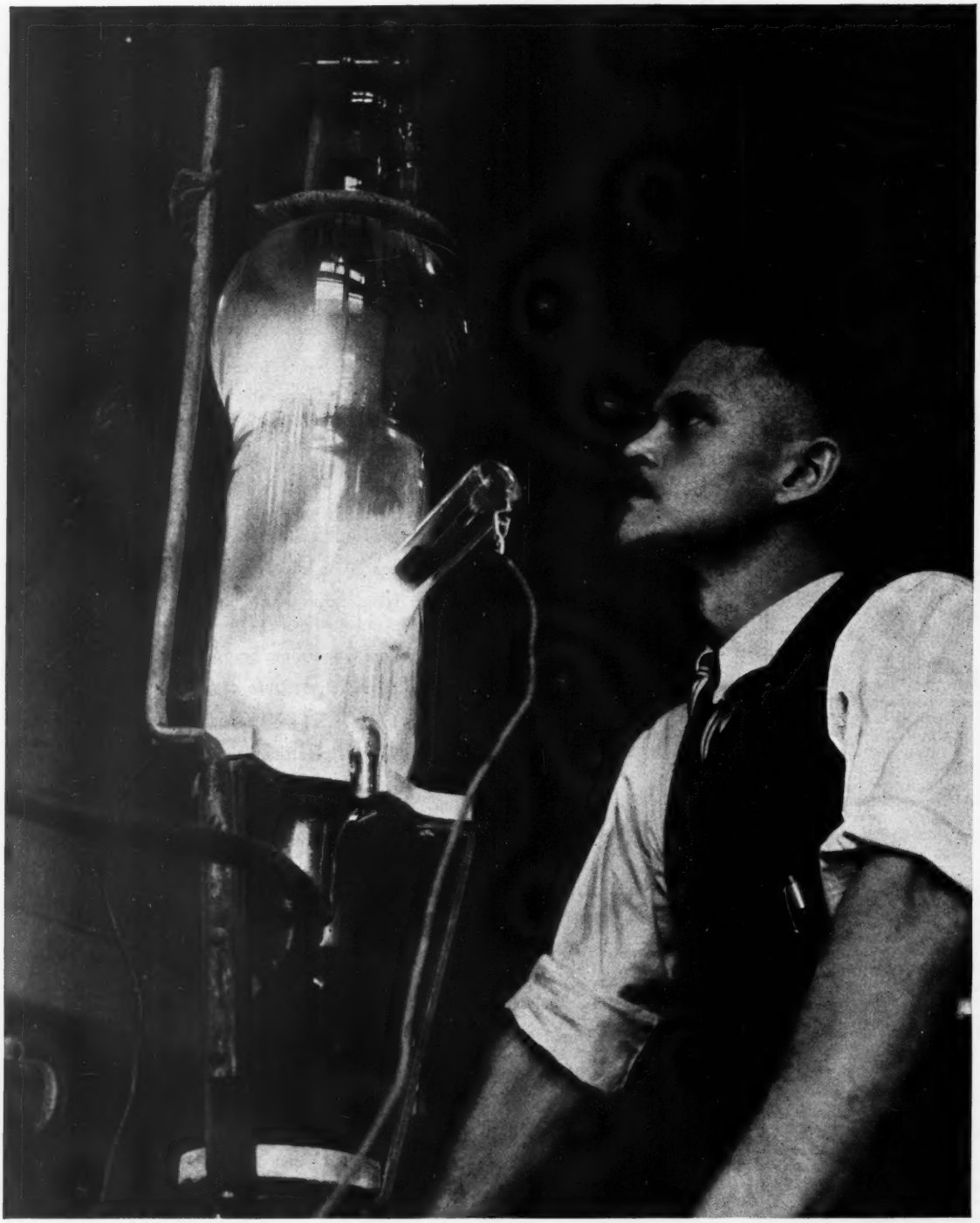


Photograph, courtesy Westinghouse.

CRYSTAL GAZING, 1933. What is it, the scientist sees in this glowing tube? What fascinates him so? Visions of a new and greater age in Electrical Engineering—of dreams yet to be realized? Visions of systems operated by and controlled by vacuum tubes—tubes of which this unit carrying 900 kw. at 5000 v. is only a forerunner? If the brief history of the vacuum tube thus far is any criterion, these dreams will be realized. The destiny of civilization to a large extent probably lies within the confines of these glass walls.

WITH THE EDITORS

Parades Past the Power Plant

ACCOMPLISHMENTS of the closing year should be reviewed individually and collectively, for some ideas which have been developed into useful equipment stand out as individual units applicable in almost any power plant, others require a complete change of surroundings in order to render their best service. This idea is depicted by our artist on the following page as a parade in which each outstanding development, small though it may be, fills a space in the marching procession of the year's accomplishments. Each is needed but all must be seen in review to give the correct impression of the advancements that have been made.

This parade goes on continuously, most of the time with familiar objects modified to harmonize with changed surroundings but occasionally an entire stranger lines up in the procession and his appearance modifies the whole character of the succeeding parade. He becomes a leader, perhaps the starter of a new parade that attracts the attention of all spectators.

As these parades pass the power house door, each marcher makes his appeal for a job in the plant, for the unemployed among them is high in percentage, yet the little known, unseasoned power house servant under the watchful eye of an interested engineer has saved many a power plant from the auctioneer's block.

Dreams come true, ideas crystallized, visions materialized. This probably is the best way to summarize the progress of the past year in the power plant field.

Preparation Time

WHEN THE LOAD is light it is difficult to keep routine matters moving in their normal course. The nervous tension created by a busy atmosphere stimulates a mental alertness which is to the organization what good lubrication is to the machine. When things are slow this nervous tension is removed, somewhere there is a mental unbalance which manifests itself in low morale which, like a hidden ulcer, slowly eats away the foundation of the organization.

It is impossible to put a finger on the source of infection and say "There is the trouble!" It is not always due to idleness because as a rule men are busier now than before. There is a grain of truth in the depression jest that "One man does two men's work for half a man's pay." Perhaps it is an unconscious fear of what may happen tomorrow, perhaps it is a feeling of futility but, regardless of the cause, the fact remains that trying to maintain the morale of an organization during the depression has been as important as trying to keep the red ink at a minimum.

As an important part of any organization, a part closely related to and contacting all departments, the power department problem has been acute, perhaps because from this close contact they share dissatisfaction of all other departments. Psychology has not yet advanced to the point where a definite solution of any given problem can be made, yet constructive mental effort has been found beneficial in improving mental conditions. The human mind, as exemplified by the present civilization, likes to tear down so as to rebuild better, to approach one step closer to perfection.

Never before has the power plant man had greater opportunity for constructive thinking of this kind. Advances made in recent years have been so remarkable that it is possible to point a finger at practically anything in an existing plant and say, "That can be changed with advantage to the entire plant." This is particularly true of the smaller equipment, pieces that can be improved and developed in the laboratory. During the depression practically every manufacturer has redesigned his entire line, improving equipment which even before the change seemed perfect.

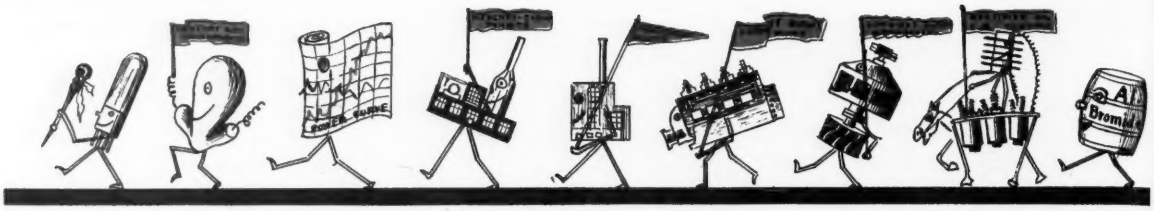
Application of this new equipment seems hopeless at the present when money is so scarce, yet the study, involving that questionable "If" offers a range of possibilities which include the independent variable load. "What will the load be in the future?" Thus broadened to include the business as a whole the entire problem involves a fresh point of view, a wider interest that carries the employee out of his own rut and encourages interchange of information between individuals and departments.

See that the men know of recent equipment changes, supply them catalogs and available data, encourage suggestions as to changes, determine under what load or business conditions these changes could be justified in accordance with the companies' policy. A constructive interest aroused, the question of low morale will take care of itself and you will have an organization that can be depended upon to produce results when the time comes for unusual effort and activity.

Possibilities of Increasing Load Offered by Electrochemistry

THE CHEMICAL industry is a field of more than passing interest to the producer of electricity. Many of our major industries are made possible only by cheap electricity, the aluminum industry being an outstanding example, each pound taking an average of over 11 kw-hr. to produce. The same process used for aluminum-fused electrolyte is also used for magnesium, beryllium and lithium, all of extreme importance in light weight metal alloys and increasing in importance rapidly. Zinc, copper, alkali, chlorine, electroplating and the electric furnace all form part of a vast chain which research is forging closer and closer to electric power.

Central station power loads are down much below their normal capacity and an electrochemical load is ideal for bringing up the load factor of a plant. Utility plant officials may find their best answer to an unsatisfactory load condition is to engage in the production of some new metal which gives promise of an expanding market.



The March of Progress Ac

IN point of technical development the year 1933 was decidedly active. Four central station projects of unusual and major importance were completed, one of which has a thermal efficiency of close to 100 per cent and a cost of $69 per kilowatt to build. A new industrial plant with a unique self liquidating plan, effected remarkable savings. Another serving a paper mill saved $650 a day the first few months of its operation. A new plant for the largest hospital in the world. The world's largest Diesel plant, construction of the world's largest hydraulic generators, a new scheme for wind power development, new oiling systems for turbines, new machines for binary vapor cycles are other examples of the year's progress. In the electrical field, new thermionic tube applications, improved motors, new and better circuit breakers, larger transformers, new systems of excitation were features of the year's developments.

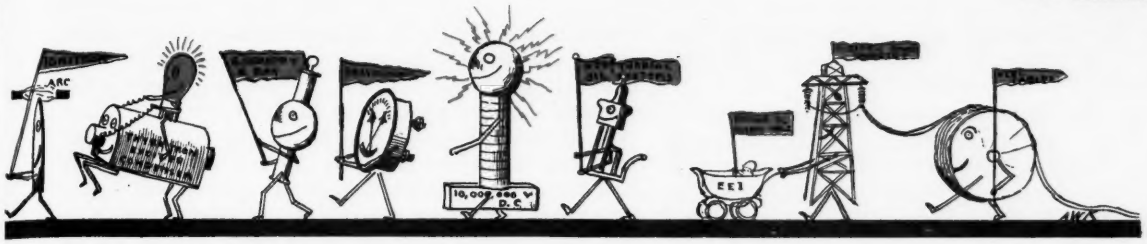
IN PRESENTING THIS review of development in the power industry for the year 1933, we are conscious of something akin to an inferiority complex in our inability to discuss anything as startling as would a reviewer of the general economic situation during the year. For regardless of one's opinions or political affiliations or whatever else one may say about the year 1933, certainly there has been plenty of action and compared to the rapid fire series of events beginning with the bank moratorium, through NRA and AAA and ending in Heaven knows what for it is still only November as we write, developments in the power industry seem tame and unimportant.

But as we suspected this apparent quietness in the power industry is largely imaginary for even the most casual investigation into the activities of the year discloses unusual, if not startling, progress in every direction. An encouraging aspect of the power industry of interest to everybody is the increase in the power output since the early part of the summer. Since 1929 the electric power output had been decreasing continuously and in March of this year was 1,375,000,000 kw-hr. per week. In April, however, there was an upturn which continued more or less steadily through the summer and reached an approximate level of around 1,625,000,000 kw-hr. per week during the fall months, a level considerably above that of the corresponding period last year. If developments have been less numerous than in previous years, and even this we are not prepared to admit, they certainly have been more unusual, particularly with respect to plant design. Comparatively few plants were built but those that were are all of radically different design and represent different trends in engineering development. Much more though seems to have been put into their design; engineers, it appears, have had more time to work out their pet theories; and under greater economic pressure, have reduced costs and improved thermal efficiencies to an extent that was unheard of a few years ago. With a simple regenerative cycle, with three stages of extraction, Buzzard Point produces a kilowatt-hour for 12,200 B.t.u. The Schenectady Mercury Vapor-Steam plant serving the General Electric Co. plant with heat and the New York Power and Light Co. with electric power, using no condensers, has a thermal efficiency close to 100 per cent and cost only $69 per kilowatt to build.

These two stations, Schenectady and Buzzard Point, the latter serving the city of Washington, D. C., are among the four central station plants completed this year. The other two are Burlington and Kearny, both of the Public Service Electric Co. in New Jersey and both of which were extensions to existing plants. The Kearny installation involves the use of a mercury vapor boiler similar to the one at Schenectady and is expected to show a thermal effieciency of 59 per cent! The Burlington job was an outstanding example of central station rehabilitation.

Several new central station installations are under construction. Of these the Port Washington station of the Milwaukee Electric Railway and Light Co. and the new addition at Richmond are perhaps the most important. Port Washington will not be completed until probably in the fall of 1934 and the Richmond unit about the same time. Port Washington will be a 1400-lb. plant and, contrary to the general trend, is using the bin or central system of pulverized coal firing. Richmond is notable because of the new 160,000-kw. unit to be installed there.

Development has been confined not only to the central station field, however. In the industrial field several important projects were finished. An outstanding example in this class is the Jacob Decker plant at Mason City, Iowa. This plant was completed late last fall but is of interest this year because of its remarkable oper-



ross the Power Plant Stage

ating record. In the period between Nov. 1, 1932, and April 14, 1933, the total operating cost of this plant was $45,671.99 against $80,939.81 for the corresponding period the previous year, a gross saving of over $35,000 for the 165 day period, or a net saving of $4000 after rental payments are deducted. This plant was remarkable also because of the self liquidating plan involved in its financing. It was a revolutionary departure from traditional packing plant engineering and the unique financing plan employed opens up new avenues to industrial power expansion.[1]

The whole question of industrial power expansion, indeed, is one of most active interest at the present time and is one which holds forth promise of great development in the next few years. For some time to come at least, the central station industry will undergo only moderate expansion. With the exception of isolated cases there is more than ample central station generating capacity in this country for the immediate future. Industrial power plant practice, on the other hand, can be improved considerably and the success of such projects as the Decker plant should stimulate this field of activity. This phase of power plant development is discussed in greater detail elsewhere in this issue.

Two other excellent examples of industrial plant practice were completed this year, the two new power plants for the Forstmann Woolen Co. at Passaic and Garfield, N. J. These are modern in every respect and show the influence of central station practice upon industrial plant design. Another important plant was that of the Bogalusa Paper Co. in Louisiana which was constructed in record time and already shows a saving of $650 a day.

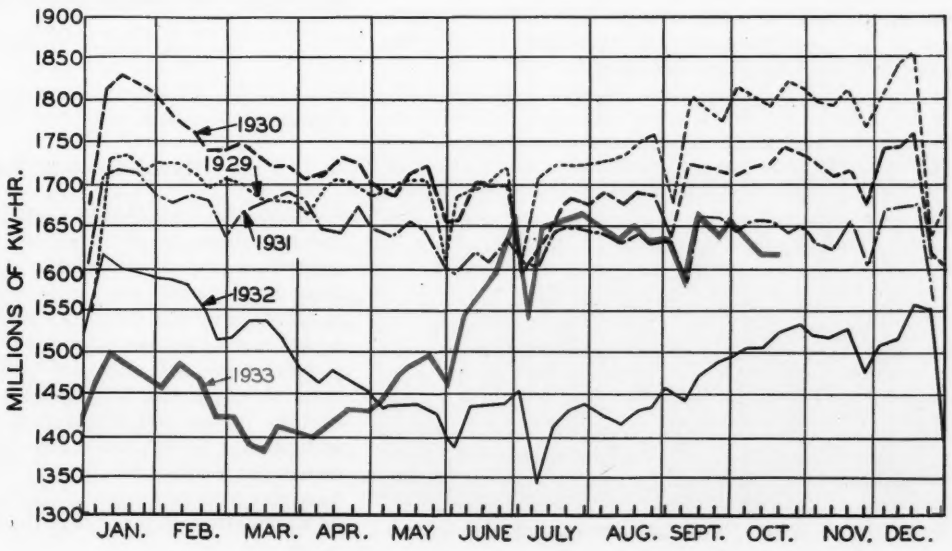
Quite different in design, yet modern in every respect, is the power plant at the New York Hospital, Cornell Medical Center, the largest hospital in the world. This was a stupendous development, costing $42,000,000, requiring 3 yr. for construction and involving 1,963,700 sq. ft. of floor space. All the heat, power, water refrigeration and numerous other services for this great institution are supplied from a central power plant. The most interesting feature of this plant are the three twin cylinder engine generator units. These units each drive a 1250-kw., 3-phase, 60-cycle alternator and a 300-kw. direct current generator on the same shaft.

These are the principal plant developments of the year but by not means all. There were numerous other installations and rehabilitation projects. Because of the legalizing of 3.2 per cent beer many brewery plants expanded their power plant facilities. These plants for the greater part have obsolete equipment and the rehabilitating of these plants will provide considerable activity in the power industry for several years to come. Thus far, brewers have been too busy keeping up with the demand for their product but as competition becomes more severe, they undoubtedly will give more attention to the economical generation of power and we

[1] "A New Deal" in Industrial Power Supply, July, 1933, p. 282.

THE ELECTRIC POWER PRODUCTION CURVE FOR 1933

Since the middle of March until the end of July there was a steady rise in electricity production. Since then the production level has been maintained at approximately the 1931 level



may look for considerable plant modernization. The same is true, of course, to a smaller extent of other industries that have been dormant.

In considering plant development, we must not overlook the 35,000-hp. Diesel plant at Vernon, California, which was placed in service this year. This station is notable because it is the largest Diesel station in America and its operation will be of great interest to central station operators. Its operation cost is expected to be extremely low.

The Diesel engine is steadily gaining in popularity, especially in municipal plants and in the industries, and during the year numerous installations were made. Among the more interesting of these was the 2850-hp., 8-cylinder unit for the Rockville Center Municipal light plant, the new two cycle units installed in the "show" plant supplying the General Motors Building at the Century of Progress in Chicago. A number of other units are being installed at the present time. According to "Diesel Power" the total number of Diesels produced in this country number 38,453. Of these, 31,453 have been produced since 1920.

In the hydroelectric field, there was comparatively little development during the year. No new installations of importance were completed and no projects of consequence were started in this country, though preliminary investigations were begun on the Grand Coulee Dam in Washington. Work on the Boulder Dam project continued throughout the year and is well up to schedule. Construction of the dam and power house was started early this year and the initial units are scheduled to be placed in service in 1937. This is by far the most important hydraulic project under construction. It has many interesting aspects as discussed in the article on hydraulic development in this issue. The St. Lawrence waterway project still remains largely a political controversy and while it has been under consideration the initial installation of another development equally large on the St. Lawrence has been placed in service. This is the Beauharnois development, an all Canadian project, with an ultimate generating capacity of two million hp. The initial installation was placed in service last fall, but its details were not fully disclosed until this year. A number of interesting hydroelectric projects are under way in Europe, several of which involve seasonal or pump storage. The Schluchsee project in northern Germany and the Oberhasli development in Switzerland are examples.

No review of developments in the power industry would be complete without some mention of the interesting experiments in progress on the generation of electricity from wind power. This scheme involves the so-called Fletner effect used in the rotor ship which crossed the Atlantic Ocean several years ago. A test installation has been built at West Burlington, N. J., and recent experiments have been reported to be encouraging. The plant consists of a duraluminum cylinder 90 ft. high and 28 ft. in diameter rotated by an electric motor. With a 10 mi. per hr. wind, and a peripheral velocity of as high as 50 mi. per hr., the tower indicated a translational force of 8000 lb. at right angles to the direction of the wind. Originally the project was sponsored by the Public Service Electric & Gas and a number of other companies and the experiments have had the active interest of C. F. Hirshfeld, research engineer of the Detroit Edison Co. In the envisioned commercial installation, twenty to a hundred motor rotated cylindrical towers mounted on railway trucks would move along a circular track under the effect of the wind, producing energy from axle-geared generators on the trucks. This energy would be delivered to a circular trolley line for further transmission to the load centers. Julius Madaras, the inventor, claims a 50,000-kw. rotor plant would cost $2,000,000 against $8,000,000 for a hydro plant and $6,000,000 for a steam plant. Dr. Madaras apparently is unfamiliar with the fact that central stations are being built for $65 per kilowatt.

FIG. 3. NEW YORK HOSPITAL, CORNELL MEDICAL CENTER. (Photo, courtesy Elliott Co.)

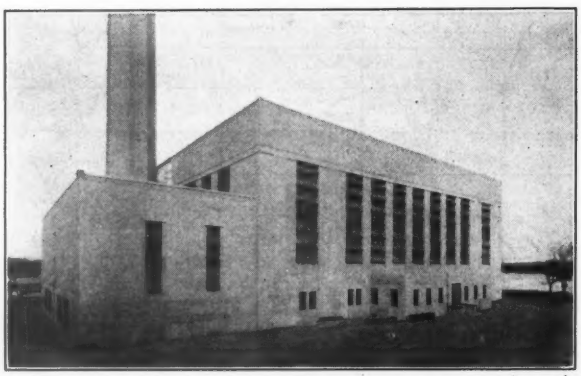


FIG. 2. BUZZARD PT. PLANT

Development in Equipment

There has been steady progress in the development and refinement of all types of equipment used in the generation and distribution of power. In most cases these developments are the natural result of experience, in others they are forced by virtue of sheer necessity. An excellent example of the second class are the changes in lubricating and governor oil piping systems on turbines, due to the serious oil fires which have swept the country in the last few years. These fires also have instigated a search for a non-inflammable lubricant to be used as a substitute for oil. Efforts in this direction have met with some success and before long we may see an application of these new fluids.

Along similar lines, but for quite a different purpose, is the search for new compounds for use in binary vapor systems and in heat transfer and storage systems For comparatively low temperature heat transfer. diphenyl compounds have been successful, but for high temperature work, new materials are under consideration. Among these Aluminum Bromide and Aluminum Chloride (NS fluid) are notable. The former has a melting point of 200 deg. F. and a boiling point of 500 deg. It is non-poisonous and the 22 lb. of the substance required for a kilowatt of capacity will cost only $2.00. In a binary cycle it is said to be better than mercury. Another fluid similar to this is NS fluid

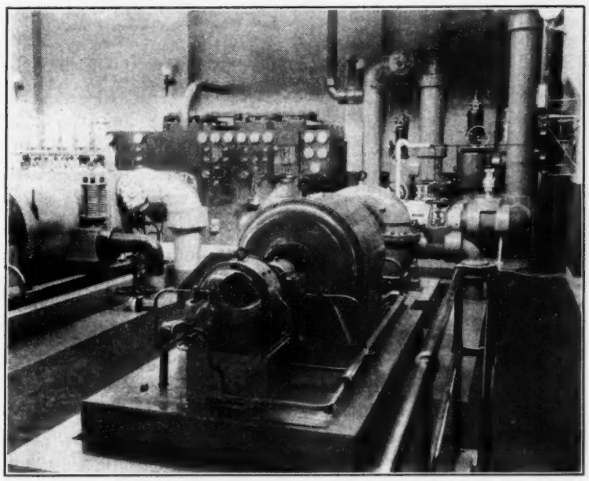


FIG. 4. THE TURBINE ROOM AT THE DECKER PLANT

(Anhydrous Aluminum Chloride and Sodium Chloride). This solidifies at 302 deg. F. and can be used at temperatures up to more than 1500 deg. It has exceptional heat capacity, is non-corrosive to iron or ordinary metals and has a low cost.

In an effort to reduce auxiliary power consumption, new feedwater pumping and heating systems are being developed. The Port Washington high pressure heaters described elsewhere in this issue are extremely novel in this respect.

Turbine sizes have not increased nor has there been any increase in temperature over the 1000 deg. unit installed at Detroit. In England, however, a 24,000-kw., 1850-lb. unit is under construction for the Thermotechnical Institute at Moscow and which is designed for 932 deg. F.

In the internal combustion field, the suggestion of using hydrogen boilers and engines for peak load service is of interest. This is the natural consequence of the development of a high pressure hydrogen electrolyzer.

In the field of steam power transmission, the 400 lb., 750 deg. steam line between the Mercury Vapor Steam Plant and the General Electric Works of Schenectady is of great interest. This line completed this year is about a mile long and is entirely welded. If no insulation was applied to this line the entire output of the plant, 20,000 kw., would be radiated as heat.

Thermionic tube development and applications continue to dominate developments in the electrical field. Each day brings new uses of these marvelous devices and each new use opens up new possibilities for other

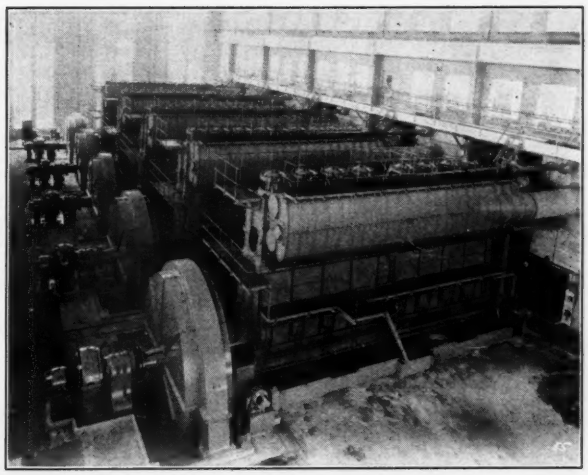


FIG. 5. VERNON DIESEL PLANT. (Photo, Courtesy Diesel Engine Power)

uses. In the central station field the latest application is their use for furnishing excitation current for a synchronous condenser. Another application is their use in replacing the commutator on direct current generators and motors and in the control of synchronous motors. In the latter field they are capable of delivering current of any frequency and voltage to the motor from a constant frequency, constant voltage source.

No unusual developments were made in generator practice this year. Sizes, voltages, and speeds remain at the previous year's maximum in this country but in Europe this year an 80,000-kv.a., 3000-r.p.m. unit was built. This, it is claimed, is the largest unit operating at this speed in existence.

Hydraulic generators on the other hand this year took a step forward in the units ordered for Boulder Dam. These are to be the world's largest, both physically and electrically. Construction of these machines has just been started.

In the field of motor applications an unusual installation was a 1000-hp., 512-r.p.m. synchronous motor for rubber mill service which can be brought to a stop in 1¼ seconds. In another instance, an 800-hp., 900-r.p.m. motor was installed which has an efficiency of 97.6 per cent. A small synchronous motor was made and operated at 42,000 r.p.m.

Transformer sizes are still increasing. At State Line a 3-phase regulating transformer of 100,000 kv.a. was installed. It is said to be the largest of its kind. A new tap changer has been developed which makes internal arcs impossible. The interconnection of primary lightning ground with the secondary neutral and distribution transformers continues to prove of value. For insulation the use of Pyranol in transformers and capacitors appears to have advantages and its use has decreased size of units and lowered costs.

This year witnessed several improvements in circuit breakers. A new compression type low voltage air circuit breaker makes use of the pressure developed in a closed chamber to extinguish the arc. Another new breaker of the oil blast type successfully withstood 10,000 operating cycles at 1200 amp., 2300 v. For operating solenoids from a.c. circuits, application has been made of the disc type rectifier. In the purely experimental field two interesting devices were the air-stream

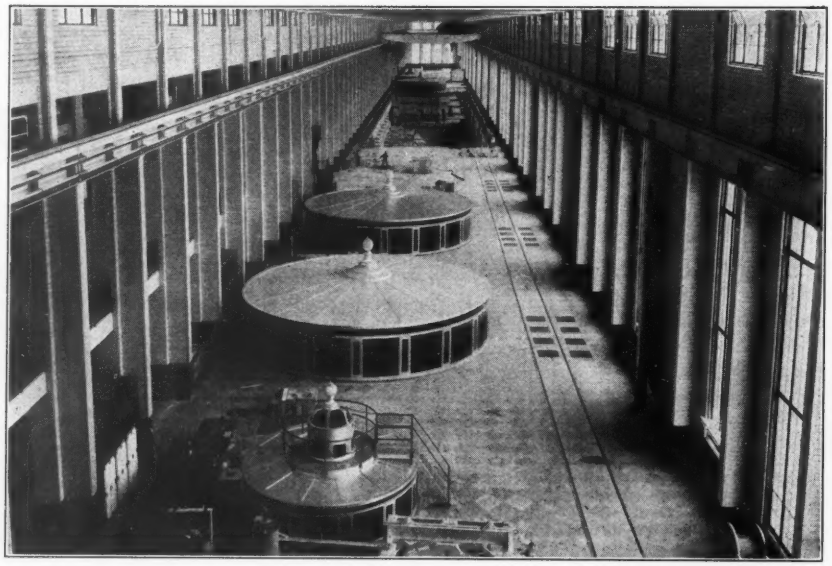


FIG. 6. THE MAIN GENERATING ROOM OF THE BEAUHARNOIS PLANT

This plant will have an ultimate generating capacity of 2,000,000 kw. It is on the St. Lawrence river and will probably be the world's largest plant under a single roof. (Photo, courtesy W. S. Lee Engineering Corp.)

and steam-blast circuit breakers developed at the University of Colorado.

Transmission practice was unmarked by any startling developments but improvements were made in every branch of the field. Interesting was the report of one system operating a system of 374 circuit miles which went 1½ yr. without a single flashover. Deion flashover protectors and expulsion protective gaps have found increased usage with good results. Underground cable in wood conduit was a unique feature of the distribution system at the Chicago Century of Progress. A new cable developed for use on low voltage, it is claimed, will burn clear without smoke and is inflammable. From England recently came the announcement of a gas-filled cable. The voids between layers of paper in this cable are filled with nitrogen gas, the entire cable being pumped full of nitrogen gas at pressures of from 90 to 100 lb. and sealed off.

In the instrument field, new vacuum tube applications are numerous. A new photoelectric recorder is so responsive that communication circuits have been analyzed with it. A supersensitive amplifier measures currents of as low as 10^{-15} and 10^{-17} amps. A new low-energy synchroscope, a new type portable ammeter, a portable multi-purpose oscillograph and a portable circuit analyzer are other developments of the year in this field. A new mercury vapor detector developed is sensitive to one part in a hundred million. This also is a photoelectric device.

Dr. Slepian added to his notable list of achievements this year in announcing a new method of initiating an arc, his Ignitron control. Simple, cheap and effective, this opens up new possibilities in control circuits. The condenser discharge method of control, though not new this year has had new applications, one in particular, the electronic voltage regulator. A new direct-selection supervisory control system saves time and is simple in operation. Numerous photoelectric applications also

FIG. 7. THE MERCURY VAPOR STEAM PLANT OF THE GENERAL ELECTRIC CO. AT SCHENECTADY

Started late in October this plant supplies 20,000 kw. of electrical energy to the N. Y. Power & Light Co. and 630,000 lb. steam per hr. to the General Electric Plant. (Photo, courtesy General Electric Co.)

were made, one of particular interest in the power field is in connection with water treating systems.

In the field of pure and applied science, developments have been too numerous to permit of detailed consideration here. Chicago this year saw the installation of an 800,000 v. X-ray equipment for medical work. At Massachusetts Institute of Technology a ten million volt electrostatic generator was built. This is intended for use in atomic research, a field which is tremendously active and filled with amazing potentialities. Cosmic ray research also is in progress all over the world and this year Prof. Millikan contributed new data in support of a selective distribution of energy values. Dr. Mouromtseff reports the successful application of high frequency fields to the destruction of grain weevils. A standing wave oscillator operating between 40 and 100 megacycles with 20-kw. output is used for this purpose.

Non-linear circuits developed last year, this year have been applied to airport lighting. In lighting, the sodium vapor lamp had the first commercial application in the country this year. Sodium in pipes has been considered as an electrical conductor in place of copper and experiments were made to test the feasibility of this scheme. In California, Prof. Lawrence developed equipment for the production of 25 million electron volts for atomic research, and Prof. Anderson at the University of California claimed that he had obtained proof of the actual creation of matter by the cosmic ray in the laboratory.

NON-TECHNICAL DEVELOPMENTS

Aside from the numerous developments in the technical and commercial side of the power industry there were many developments in the personal and economic side. The year had scarcely started when came the announcement of the dissolution of the N.E.L.A. and the formation of the Edison Electric Institute a move which brought sadness to the heart of many old timers in the electrical industry. This move was undertaken ostensibly for the purpose of protecting the good name of the industry but rumors are current that the real reason was a shifting of controlling power from one group to another. The Institute held its first convention in Chicago in June, a quiet, dignified and altogether very businesslike affair, markedly different from the lavish, entertainment-providing conventions of the old National Electric Light Association. The feminine element which formed such a part of the N.E.L.A. conventions at Atlantic City was almost entirely lacking. All social affairs were eliminated. The convention was attended by 1100 utility men, mostly of the executive branches.

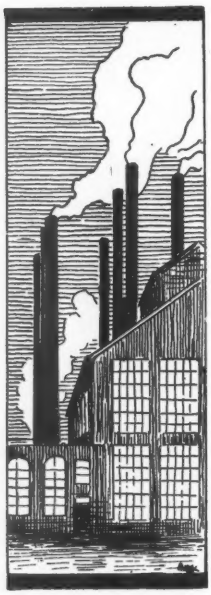
The event of outstanding importance in the Technical Society world this year, however, was the joint meeting of the American Association for the Advancement of Science and Associated Societies in Chicago in June. This was without question the largest assemblage of engineers and scientists that has ever gathered together anywhere. For two weeks engineers and scientists from all over the world, at scores of sessions, discussed problems of mutual interest. The range of thought covered by hundreds of papers was truly prodigious. Every field of scientific and engineering work was represented. The mere listing of the papers and the sessions required a 144 page book. There was entirely too much—that was the only criticism. On the whole, considering the magnitude of the undertaking, its complexity, the presence in Chicago of a World's Fair, the affair went off beautifully. The Century of Progress itself, of course, was of outstanding interest and the underlying reason for this joint meeting.

Approximately at the same time the engineering societies of this country were meeting in Chicago, power engineers of other countries assembled in Stockholm for the 1933 sectional meeting of the World Power Conference. The technical program here included over 200 papers. Subjects discussed were "Steam from Canadian Hydro", "Interconnection of Steel Mills and Central Stations", National schemes for economical power generation, Use of roller bearings for large electrical machines, Power for Aluminum, etc. The paper on Power for Aluminum was of interest because it emphasized the fact that to make one ton of aluminum requires 20,000 kw-hr. of electrical energy. This same point was forcefully brought out by Colin Fink at one of the sessions of the A.I.E.E. meeting in New York in January. It implies an enormous need for cheap electric power in the years to come.

AT the World Power Conference which was held in Stockholm last summer, it was pointed out that in the manufacture of aluminum, 20,000 kw. hr. of electrical energy are required to produce one ton of metal. This indicates what may be expected of the electrical industry in future years, for the demand for aluminum is steadily rising. In a lecture before the American Institute of Electrical Engineers, Colin Fink pointed out that the applications of electricity to the chemical processes are increasing at a startling rate. In another ten years, the electric power consumption for the electrochemical industries will be twice what it was at the peak of 1929, it will be at least 30 billion kilowatt hrs. a year or about 1/3 the total power generated in the United States today.

And finally, in concluding this review, though it scarcely seems necessary, we must mention the NRA. The NRA and other things that are going on in Washington affect the power industry as well as every other industry. In the case of industrial power plants, their operation undoubtedly will come under the codes of the respective industries of which they are a part. As for the Central Stations, they will operate under the code submitted to the NRA by the Edison Electric Institute. This code was submitted early in August and immediately it caused some dissent in the Institute membership. Both the Hartford Electric Light Co. and the Consolidated Gas, Elecriet Light and Power Co. of Baltimore indicated their inability to sign it and resigned from the Institute. The difficulty involved relates to the question of rates, and a potential conflict between state and federal authority.

POWER PLANT ENGINEERING December 1933



THE ECONOMICS OF P

The Central Station and the In compete or can they work to get

By GEORGE A. ORROK
Orrok, Myers & Shoudy
Consulting Engineers, New York, N. Y.

AT THE ANNUAL Meeting of the Power Division of the American Society of Mechanical Engineers, H. D. Harkins presents a well considered review of the many cases where industrial power plants have been tied in to Central Station systems, playing the usual part of a customer but also acting as a part of the utility generating system and feeding power and sometimes steam as well into the Central Station system. Following this paper, V. E. Alden has gone into the design and operation of industrial plants with the same thoroughness and particularity ordinarily applied to the more pretentious Central Station which it may tend to approach in point of size. The Economics of the Central Station industry are well known and the prices at which power is sold to consumers is common knowledge. These prices have been plotted by P. P. Stathas in his paper "Fundamental Relations between Price and Consumption of Electric Service," N.E.L.A. Bulletin, August, 1932, and curves have been drawn not alone for the United States but for other countries. Figure 1 reproduces one of his curves redrawn and extended. Figure 2 shows other rates in use in many places with the variations of demand, load factor and output. We know just what price must be paid for unlimited service at high load factor and how the price varies with varying load factor and quantity. Transmission and distribution costs have been investigated and underground, overhead, network and shoestring costs are to be found in many reports and papers. We have government figures of the salesprices for such powers as the St. Lawrence and Boulder Dam.

The variation in price is large. The rates run from firm power at $6.00 per kw. year (water power in bulk for metallurgical purposes) about .075 cents per kw-hr. to a very small household customer at 10 to 15 cents per kw-hr. The use in the first case may be as high as 100,000,000 kw-hr. per year, while the use of the small domestic customer in the second case does not exceed 100 kw-hr. per year. Both are extreme examples but the usual range in large systems is from 7 mills to 8 cents covering the range between 20,000,000 kw-hr. per yr. of high tension-high load factor service and the 300 kw-hr. per year household service. The usual industrial plant is around 40 per cent load factor from 500 kw. up using 2,000,000 kw-hr. or more per year and earning a rate of about 1.5 cents, decreasing with increase of size and use. The large plants would range from 5,000 kw. to 10,000 kw. with rates reaching down to 7 mills.

If power was the only desideratum, industrial power plants would be few indeed and would only appear in very favorable locations where cheap fuel, labor and construction might be found. All industries in reach of central station power would of necessity be customers since it takes very good design, construction and operation to make power at Central Station prices in so small a plant. But the complication of the use of heat as well as power, with the power as a by-product and costing between 6 and 4 mills or perhaps less accounts for the existence of perhaps half of the industrial power plants, the other half being due to the absence of Central Station service and other special reasons. The competition between the Central Station plant and the industrial plant is keen with by-product power or waste steam as the deciding factor in the large majority of cases.

In the larger centers, particularly in the northern half of our country, the district steam heating company furnishes steam for heat and power. These systems may be run in connection with the power company and in

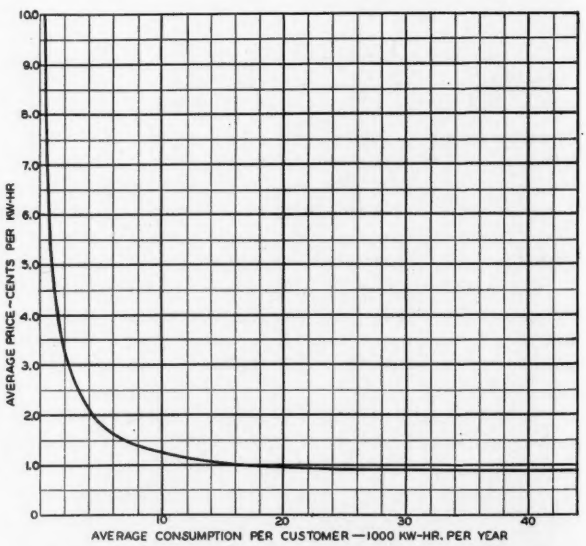
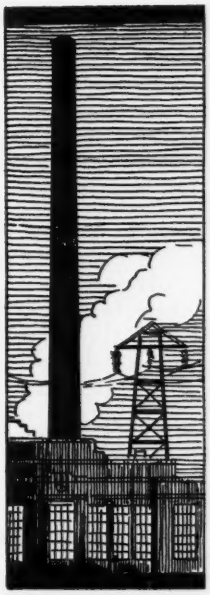


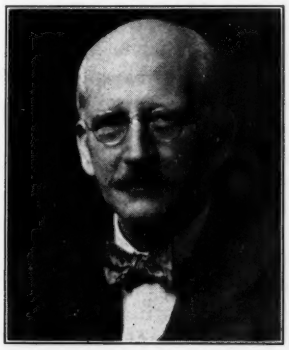
FIG. 1. FUNDAMENTAL RELATIONSHIPS BETWEEN PRICES AND CONSUMPTION OF ELECTRIC SERVICE

F POWER GENERATION



he Industrial Plant: Must they to gether for the Common Good?

some cases make power to distribute as well as steam. Unfortunately this combination has not worked out very well since the peaks of the two services are about 8 hr. apart and full benefit cannot be obtained unless the power system is much larger than the steam system. Steam distribution is limited as to distance as the mains are large and costly, while power distribution is comparatively cheap where overhead circuits may be used. The steam supply business is limited to rather compact, thickly settled districts and is at its best in the city business center. In such localities it would appear essential from the standpoint of the public welfare that both central station electric and steam service should be used to the largest possible extent to restrict the combustion of fuel to those plants of sufficient size to warrant the installation of the best types of furnaces and the proper smoke and dust elimination devices. The transportation problem which in the congested districts of all of our large cities is most difficult and pressing, would be lightened by the removal from the streets of the transportation of fuel and ashes to and from the many individual buildings which might easily and more satisfactorily be served by the Central Station.



GEO. A. ORROK was born in Dorchester, Mass., July 3, 1867. He graduated from Massachusetts Institute of Technology and, while a young man, worked as journeyman, carpenter, machinist and pattern maker and spent two years teaching mechanical engineering at the Ogden Military Academy and the Agricultural College of Utah. From 1892-1898, he was in the employ of Dr. F. S. Pearson as draftsman and resident engineer engaged in the building of the West End Street Railroad in Boston and other street railway systems, the People's Light, Heat & Power Co., Halifax, N. S., and the Dominion Coal Co. of Sydney, C. B. In 1898, he entered the employ of the New York Edison Co. as draftsman, becoming later chief draftsman and mechanical engineer which position he held until 1914, being responsible for the design of many of the power plants erected in these years. As Assistant Engineer to Thomas E. Murray, he was concerned in the design and erection of many water power and steam power plants in various parts of the United States. From 1914 to December, 1928, he was Consulting Engineer for the New York Edison Co. and many other companies specializing in power generation, coke oven, and other mechanical and chemical applications, water power, etc. Mr. Orrok has made a study of European engineering practice in connection with power plants, visiting Europe many times in the last few years.

From 1911-1914, he was consulting professor of steam engineering, Brooklyn Polytechnic Inst., from 1918, graduate lecturer in steam engineering at Yale University and in recent years lecturer in steam engineering at Harvard University. With Professor R. H. Fernald as co-author, his book on the Engineering of Power Plants is regarded as an authority on power plant design. Mr. Orrok is a member of the A. S. M. E., A. S. C. E., American Institute of Mining and Metallurgical Engineers, Institute of Mechanical Engineers of London, V. D. I., fellow of the A. A. A. S. and a member of other scientific and engineering societies. He is an able lecturer and a prolific writer.

On January 1, 1929, Mr. Orrok severed his connection with the New York Edison Co. and opened offices in New York City, where with his associates he carries on his practice as consulting engineer.

Mr. Harkins' presentation makes a strong plea for the tying in of industrial power plants to the Central Station system not alone as consumers but as a part of the generating system so that savings may be made in capital investment and both the utility and the industrial plant may profit by the connection. The best example of this practice and the only example on a large scale is the system of the Union Generale Belge d'Electricite in Belgium.

In the years preceding 1925, F. Courtoy of Brussels worked up a plan for the coördination and interconnection of the power supplies of Belgium. This proposal was crystallized into fact by the appointment of a commission whose report was embodied in the law of March 10, 1925, establishing the Union Generale Belge d'Electricite. This corporation proceeded to group together all of the large producers and users of power from all sources in the eastern half of Belgium. Under the law, the consumers must take at least 1000 kw. of demand, while producers included hydro-electric and gas engine plants of 500 kw. and over, steam plants of 1000 kw. and over and such other plants of 1500 kw. and over which were not included in the above categories.

Belgian Plants All Connected to One System

These plants were connected by high tension lines into one system managed by a load dispatcher at Liege and by 1929 an aggregate of about 500,000 kw. had joined the system. The cost of generation at each plant had been determined and the cost of supplying each plant from the system, or the rate schedule, had been made. The higher cost plants had been shut down or relegated to peak load operation. The net savings for the 1928 operation were 4,217,000 francs and the profits to members were of the order of .07 cents per kw. generated. In 1929, the last year for which I have figures, the profits on a much larger business were of about the same amount with a return to members of about .04 cents per kw-hr. in that year. No figures are available for the depression years but the savings must have been much larger since only the most economical plants were in service.

The Union Generale Belge d'Electricite is a voluntary association and is held together solely by the savings made for the subscribers. Certain government plants are members and the administration is represented on the Board of Directors. The new capital

required has been furnished by both the subscribers and the government. The new scheme of operation has been very carefully worked out and the minimum size of plant has been made large enough so that troubles from the multiplicity of supplies have been negligible since the early operations. The smaller plants are customers in the ordinary sense using the Central Station service and getting the benefit of the reduced costs of service. But even in this district many small steam plants are still making their own power because of their need for

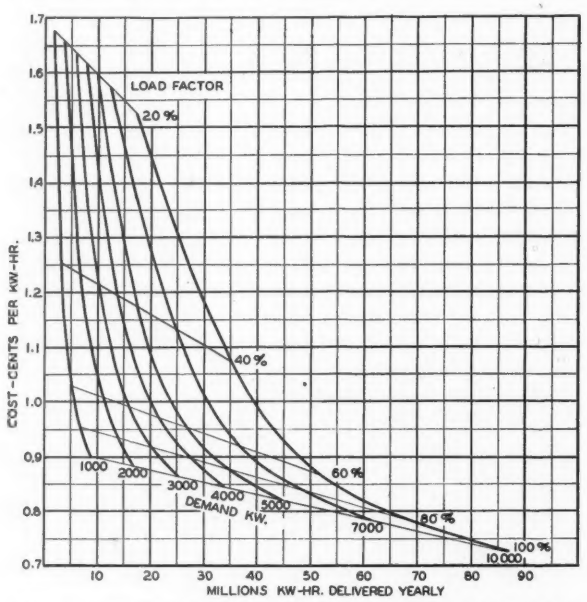


FIG. 2. RATES WITH VARIATIONS IN DEMAND, LOAD FACTOR AND OUTPUT

process steam or because of their distance from the distribution lines.

The Nova Scotia example mentioned by Harkins is small in size and the Steel Company and Coal Company which use about 95 per cent of the power are in reality one corporation. Advantage is taken of waste heat, waste furnace and oven gas and waste coal. This example and many others of similar size will usually show savings from the utilization of fuel and heat which otherwise would be wasted or used at a very much lower efficiency. It will be noted that the stations of the utility and municipality because of small size and inefficiency have been shut down, leaving the Dominion Coal Company and its affiliates to manage the generating apparatus and supply the system in the best possible manner as was contemplated in the original layouts for the steel and furnace development.

Alden has also commented on the savings to be made from the coupling of industrial plants of sufficient size and proper design with the Central Station. The problem of reserve capacity is extensively discussed and his final paragraphs cover what he considers are desirable fundamentals which should be embodied in such contract relations.

"1. Provision should be made for the payment of the fixed charges on the investment in such a way that there will be an equitable division of the business risks.

"2. The contract period should be sufficiently long to permit of amortizing the investment, and provision should be made for the extension of the contract and the continued use of the facilities if this appears desirable.

"3. Throughout the contract period there should be an equitable division of the benefits of the coöperative enterprise.

"4. Cost allocations should be made upon the basis of certain agreed-upon principles of equity and not upon fixed unit costs.

"5. There should be a recognition of the fact that future conditions will differ from the present and in any long-term contract there should be provision for review and modification at stated intervals."

These provisions are most interesting as they run parallel with the Belgian law.

Mr. Courtoy in his investigations of the conditions in Belgium was forced to put a lower limit to the size of interchange plants for two reasons, the cost of the switching with safety features and the large swings in load which might be expected even with the district diversity. Customers could be protected by a reverse current relay but generating apparatus must work both ways and take the brunt of a full short circuit with the entire capacity of the system behind it.

DO YOU KNOW that in Belgium all large producers and users of power from all other sources in the eastern half of the country are grouped together, and that under the law the consumers must take at least 1000 kw. of demand by law? ¶ This is perhaps one of the best examples of a large scale tying in of central stations and industrial plants, and in the years that it has been in operation it seems to have worked out well and profitably to all concerned. The net earnings for the year 1928 due to the operation of this plan amounted to over four million francs and the profits to members were of the order of .07 cents per kw. generated.

He chose his minimum for steam plants at 1000 kw., about 1/500 of the capacity of his system, while allowing water power plants as small as 500 kw. or 1/1000 of his system capacity. In actual practice the hydro plants were at the end of a transmission line with no power used at the plant, while most of the smaller steam plants were shut down so that the average size of generating customers averaged much larger, possibly 1/100 of the system capacity.

On the experience of the first 25 yr. of the Central Station, Wordingham stated that from three to five generating units was the proper division for the economic supply of an electric system. He considered only direct current and knew nothing of high tension and interconnection. Large alternating current systems in this country in the last twenty-five years have had from 20 to 50 or more units in three or more generating centers and the capital cost of the buses and switchgear has grown from about $1.00 per kw. of installation in Wordingham's time, to $25.00 per kw. today. The switchgear is larger and more costly due to the enor-

mous power behind a short circuit in a large system and the necessity for breaking it quickly so as to avoid serious damage. What is the limit of economical size? The size in Belgian law, one-fifth of one per cent of the installed system, is certainly too small. Most operators would say that two per cent is too small and the greatest economy is obtained when the units are the largest, perhaps ten per cent of the installed capacity.

Peak capacity and emergency capacity units may be smaller but the decrease in size must be accompanied by the ability to be put on the line from cold in a few minutes. Emergencies have occurred requiring the addition of 3000 kw. per minute for three consecutive hours, a total of 540,000 kw. This additional load could have been carried by four 160,000-kw. machines, by nine 60,000-kw. machines, by 100—600-kw. machines or by 540—1000-kw. machines. It was actually taken care of by about 30 units of varying size without trouble to any customer. This particular emergency occurred on a November week day starting about 8 a. m. when every industrial plant was running full. Summer peaks or emergencies rising to the height of winter peaks have been even more troublesome because this is the overhaul period where machines are off for inspection and repair.

Central Stations and all public utilities must supply customers at all times and no excuse is accepted. Even storms and earthquakes must only cause short interruptions or the utility would soon lose its customers. They sell a service and not a commodity and no longer pull circuits on the peak or refuse to accept demands. They run 8760 hr. a year and on leap year the additional 24 hr. is taken care of as a matter of course. The industrial plant on the other hand runs 30 to 40 hr. per week (N.R.A. Code), 1500 to 2000 hr. per year or 3000 to 4000 hr. with two shift operation, which steel plants, paper and chemical plants and industrials of similar type may increase to 5000 to 7000 hr. They enjoy periodical shutdowns, strikes and depressions and rarely indeed do they have any reserve either in machinery or men. Their power expense is such a small portion of their annual business turnover (one to four per cent) that the supervision is frequently of the most rudimentary kind.

The larger and better plants, 2500 kw. and larger, could with advantage be used in connection with a utility with a capacity of say 250,000 kw. capacity but the industrial plant must be run at the order of the utility load dispatcher, when and as required, must be maintained and operated up to the Central Station standards and must be as truly dependable as any portion of the Central Station equipment. If the plant has been designed by an engineer and well constructed with well chosen apparatus so that the costs are equivalent to the utility costs; and the owner is willing to run on a Central Station schedule, then, and then only, will the connection pay both the owner and the utility company.

Industrial plants designed by the owner, the architect, or the $20 per day professional engineer, and run by a $1200 to $2000 operating engineer with the aid of the N.R.A. Code firemen and minimum rate laborers cannot be connected with even the worst run utility with advantage to anyone.

Two main reasons governed the researches of Mr. Courtoy and led to the passage of the law of 1925. Belgium is an industrial country and its fuel reserves are not large. She is already importing fuel and may

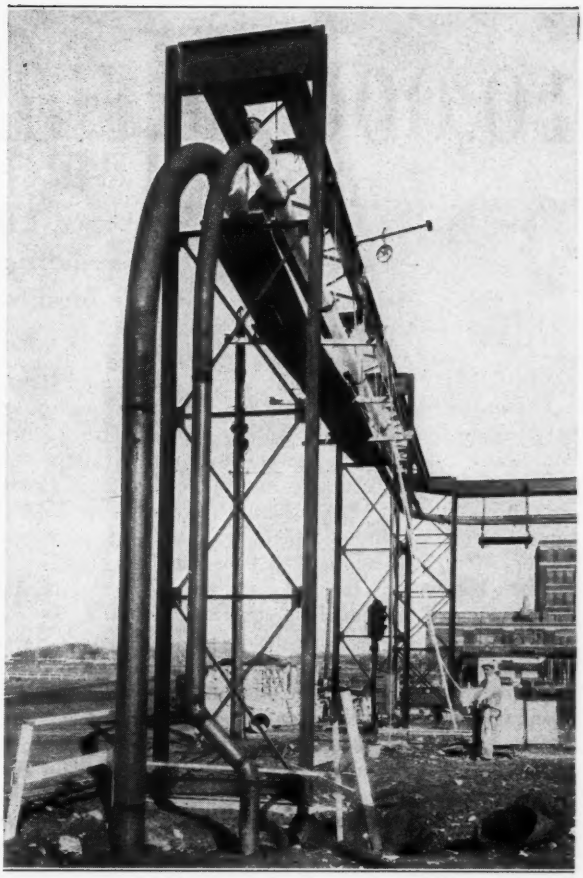


FIG. 3. 400 LB., 750 DEG. STEAM LINE BETWEEN MERCURY PLANT AND G. E. WORKS AT SCHENECTADY
This is an excellent example of coordination between a central station and industrial plant

continue to do so. The demand for conservation of fuel grew with the increase of the use of power and this policy was foremost in Courtoy's mind. The second reason grew out of the first and predicated the conservation of power and capital expenditure by using only efficient plants and taking complete advantage of diversity as well as of by-products and waste heat which many of the metallurgical and chemical plants afforded.

In this country the policy is commended because of the reduction of capital expenditure, very little consideration being given to efficiency because the utilities already lead the world in low fuel consumption as is shown by the reduction in the average use of fuel by the utilities from 3 lb. in 1920 to 1.51 lb. per kw-hr. in 1932. But much stress is being laid at the present time upon the larger amounts of by-product power available with the use of the higher steam pressures in new plants where process steam is the main consideration. The "planned economy" of 1933 and the "New Deal" all lead to coördination and combination as opposed to individual operation, and the act creating the Tennessee Valley Authority is based, among other things, on the coördination of power. The Belgian Act of 1925 is based on the same theory modified by the fact that little water power is available in Belgium and the sense of thrift of the Belgian citizenry which must see a profit in any new departure as well as the conservation and coördination of the country's resources.

POWER PLANT ENGINEERING December 1933

10,000 B.t.u. per Kw-hour

Mercury Vapor, High Temperatures and High Pressure Bring Heat Rate Figures Close to the Ideal for Present Heat Cycles.

CONTRARY to what might be expected from limited plant construction, progress during the past year has been nothing short of phenomenal. The four plants completed (Burlington, Buzzard Point, Kearny and Schenectady) and the one nearing completion (Port Washington) are all of radically different types, each representing the pinnacle of its particular line of development. To these might well be added Huntley No. 2 put into service late last year and the Decker plant, an outstanding industrial development.

In spite of varied plant designs, there are two very well defined trends: simplification by extending the unit idea of one boiler and one turbine complete with auxiliaries and further extension of high temperatures. Following the European lead, this trend toward higher temperatures has served somewhat as a check on the higher pressures. Temperatures of 850 to 1000 deg. F. allow the use of 650 to 850 lb. pressure without reheat and without exceeding the allowable moisture at the turbine exhaust. When a straight regenerative cycle with three stages of extraction, as at Buzzard Point[1] reaches heat economy of 12,200 B.t.u. per kw-hr. net, the added complications of reheat offer little attraction except in the case of very high priced fuel.

Binary Vapor Cycles

Mercury vapor just starting on its third decade,[2] the era of commercial application, offers heat rates some 2000 B.t.u. lower, in the neighborhood of 10,000, and will undoubtedly be an important factor in future power development. Studies made in connection with Port Washington Station[3] indicated that, to equal the total annual costs of a 1200-lb. condensing steam plant, a mercury cycle plant would have to operate on a 65 per cent annual load factor, in other words on unusual and base load conditions.

Where process steam is involved conditions are much more in favor of the mercury plant. For a given steam demand the mercury cycle can generate over twice as much by-product electrical power as a steam cycle, or for given steam and electrical loads, can generate by-product power at a much lower heat rate. This has been done at the Schenectady mercury vapor plant where 500,000 lb. per hr. of steam is supplied to the General Electric works and 26,000 kw. of electrical energy to the lines of the New York Power & Light Corp. Prospects for the mercury cycle at present fuel costs appears to be brightest in the combined utility-industrial plant, a development of rapidly increasing importance. Using no condensers the Schenectady plant has a thermal efficiency of close to 100 per cent and a cost of but $69 per kw. of capacity.

Outdoor Construction

Another important feature of this plant is the semi-outdoor construction, an adaption of the outdoor hydro plant which has been gaining favor in milder climates. The climate at Schenectady is far from mild, however, and some modification of the outdoor idea has been made, particularly in connection with the boilers and fuel storage.

This type of outdoor development and simplified design has been carried to its ultimate conclusion by the New York & Queens Electric Light & Power Co. in the proposed Astoria Station.[4] The complete design calls for nine 200,000-kw. units each complete with a 1400-lb., 1,700,000 lb. per hr. pulverized fuel boilers. Each unit would be complete in itself connected to its neighbor only at the coal pile at one end and autotransformers at the other. Excluding land and coal handling facilities, the estimated cost is $44.21 per kw. for the steam equipment and $10.22 per kw. for the electrical equipment, a total of $54.43. The boilers and generators could be housed for an additional $1.65 per kw. of capacity.

[1]Buzzard Point Supplies Power to Capitol City, Power Plant Engineering, p. 456, Nov., 1933.

[2]Twenty Years of Mercury Vapor Development, Power Plant Engineering, p. 263, June, 1933.

[3]Design Features of Port Washington Plant. By G. G. Post, A. I. E. E., June, 1933, Meeting.

[4]Unit Station Combines Reliability with Economy. By J. E. Goodale, A. I. E. E. New York Meeting, April, 1933.

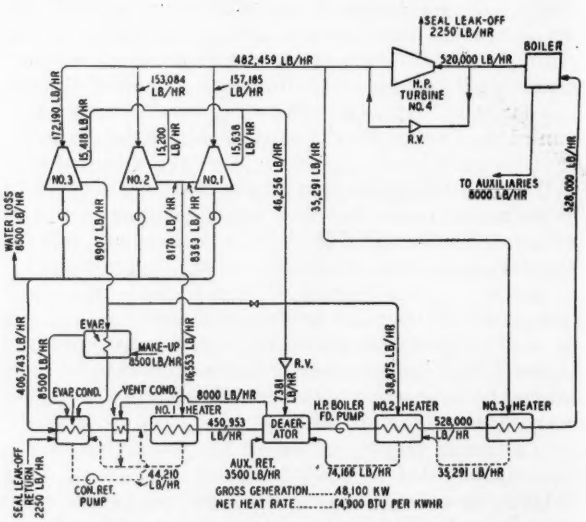
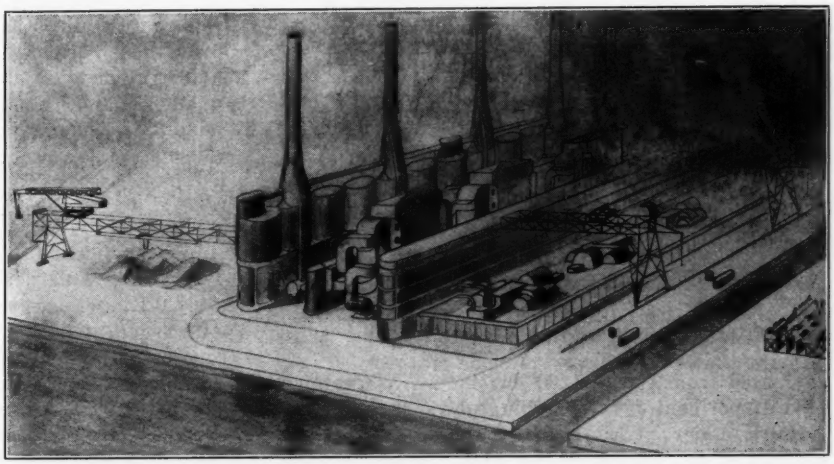


FIG. 1. HEAT BALANCE OF BURLINGTON STATION

No Longer an Idle Dream

HOW THE OUTDOOR PLANT OF TOMORROW WILL PROBABLY BE ARRANGED

Tied together, only at the coal pile at one end and an auto transformer at the other, each unit will be independent of the others, the ultimate in simplicity, a marvel of low cost construction



This trend toward lower costs has of course been under way for some time. Huntley No. 2 being an outstanding example of a low cost, high efficiency plant with an almost unbelievable flexibility, being able to carry with stability loads of as low as 6000 kw. on an 80,000-kw. machine and to pick up full load literally in a matter of seconds. This station, including coal unloading and storage with condensing water intakes for 1,000,000 kw. of capacity, cost less than $75 per kw. and has a heat rate of around 12,500 B.t.u. A straight regenerative cycle is used and all inside coal storage or bunkers are eliminated. Port Washington, a 1400-lb. reheat plant, has a reported cost, exclusive of coal docks, of $65 per kw. of capacity which is about the same as Station A, also a 1400-lb. reheat station which, however, was a rebuilt plant. Because of different fuel and operation conditions, these costs are not comparable, they simply indicate the trend toward lower cost plants. For the first time since the present era of power development started, engineers have had an opportunity to study plant design and even more radical cost cuts are predicted on future construction.

It is generally agreed that present plants closely approach the lower limit as far as known cycles are concerned. Unless something radical comes about, further reduction must be in the nature of lower costs, the Kearny installation being expected to have thermal efficiency in the neighborhood of 59 per cent. Anhydrous aluminum bromide, a cheap non-poisonous compound which has a low vapor tension and moistens iron has been suggested as a substitute for mercury in the binary vapor cycle for purposes of reducing first cost.

Heat Storage

In the past some consideration has been given to cheap peak load plants, with or with out heat accumulators[5], but with little action probable because of the fact that the new station costs have been dropping so radically that the new plants can be built almost as cheaply as the peak load equipment can be added.

Superimposing new high pressure equipment on an old plant has been practiced to a certain extent since the 1200-lb. boiler was introduced a decade ago at Edgar. This practice has been given a new lease on life by the 825-850 deg. F. development which makes it possible to dispense with reheat on these superimposed jobs.

Burlington is an outstanding example of this type of rehabilitation, of more interest perhaps to industrial than central station practice. By superimposing an 18,000-kw., 650-lb., 850-deg. turbine on three old 12,500-kw., 190-lb. turbines to make a 55,000-kw. four cylinder unit the station heat rate was cut from 24,000 to 15,000 B.t.u. per kw-hr. This unit was destroyed, unfortunately, shortly after going into operation, by one of an epidemic of oil fires which swept the country.

These fires, Harding Street, Bremo and Burlington, have caused radical changes in turbine design and arrangement. Old high temperature piping installations are being changed and future turbines will undoubtedly be built with separate lubricating and governor oil systems, like the new Richmond 160,000-kw. unit now under construction, or, with non-inflammable lubricants or both.

Auxiliary Power

Full use of extraction has made low temperature heat recovery relatively unimportant but the need for reduction in auxiliary power still exists. Complete motor driven auxiliaries are practically standard practice with such tremendous advantages that the old auxiliary steam drives in Burlington Station were replaced with motors when the station was modernized.

This need for reduction of auxiliary power consumption is acute. At the new State Line addition reciprocating boiler feed pumps will be used to save 3 per cent of the pumping power, even though the pressure was

[5]New Heat Storage System Developed in Europe, Power Plant Engineering, p. 426, September, 1933.

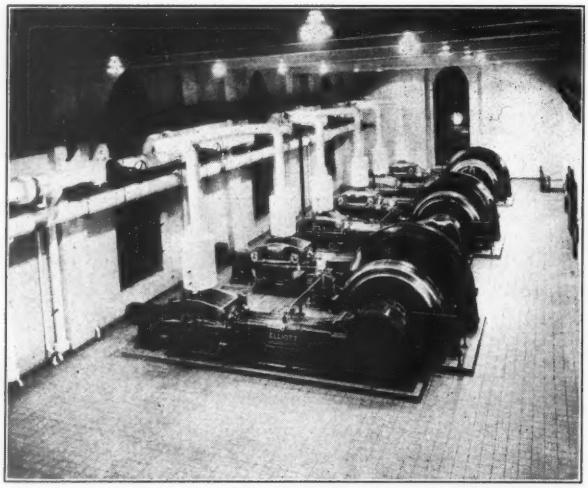


FIG. 2. VIEW OF THE ENGINE ROOM AT THE CORNELL MEDICAL CENTER. (PHOTO COURTESY ELLIOTT CO.)

increased from 600 to 1200 lb.; Port Washington will save 12 per cent of the pumping power by using closed heaters under pressure and pumping water at 200 instead of 400 deg. F. These high pressure heaters, a design used for the first time, are shown by Fig. 3. Gaskets and staybolts have been eliminated by the forged steel head bored out and supplied with an internal cover like a boiler manhole. Steel tubes will be used.

Feed pump power consumption is an important item as pressures increase. This is especially true at part load. This problem has of course always been recognized and Benson boiler installations are now operated without turbine governors[6], the boiler pressure being varied with the load ranging for one plant from 500 to 2000 lb. for loads of from 5000 to 20,000 kw.

Turbines

Turbine leaving losses in this country generally exceed those in Europe and average about 4 per cent.[7] This is because of the high vacuum used and need for high peak capacity which results in crowding unless the turbine casing is made unduly large. Turbine efficiencies are continually increasing, however, the 50,000-kw. Stall unit in Sweden having shown a reported overall efficiency ratio of 85 per cent and an internal efficiency ratio, leaving out generator and mechanical losses of almost 90 per cent. Use of turbine turning gears on large turbines has also played a part in increased performance. Due to more even heating giving better balance when starting, internal clearances can be made smaller with a corresponding decrease in internal leakage.

As far as construction goes, there appears to be no limit to turbine size but from practical load requirements the 160,000-kw. unit appears to be about as large as is required. Turbine manufacturers feel that, with hydrogen cooling, aluminum conductors and permanent synchronous condensers operating with the turbine, 375,000-kv-a. units are practical. Boilers are about in the same classification, a million and a quarter or a million and a half pounds of steam an hour have been proven entirely practical and this can be increased if desired. Welded drums have reduced boiler costs somewhat.

[6]Progress with the Benson Boiler, Power Plant Engineering, p. 378, August, 1933.
[7]Low Turbine Leaving Loss Not Always Best, Power Plant Engineering, p. 177, April, 1933.

Fuels

Petroleum coke has been proven a practical fuel source in both pulverized fuel[8] and stoker[9] installations, while the low cost of fuel oil, the rapidly spreading network of gas lines and the prospect of increased coal prices have been effective in influencing furnace designs and equipment so that change over from one fuel to another can be easily made. In fact, where oil and gas are already available, the fuels are often burned alternately as occasion demands.

Internal Combustion Engines

Development of a high pressure hydrogen electrolyzer using a 23 per cent solution of KOH and using only 0.12 kw. per cu. ft. of hydrogen (and 0.014 cu. ft. of oxygen at 60 deg. F. and 14.7 lb.) has led to the suggestion of using hydrogen boilers and engines for peak load service. This is perhaps somewhat in line with the natural gas engine-pumped hydro-storage plant at Lamoka (N. Y.), where 9500 hp. of hydraulic turbines operating at 385 ft. head and 6600 hp. of gas engines and 40,000 g.p.m. in pumps operate together on a pumped storage scheme.

In fact internal combustion engines are perhaps destined to play a more important part in the power field than steam advocates are willing to admit. The new Vernon (Cal.) municipal station with a capacity of 375,000 kv-a. in five units (ultimate 7 units), reported to cost around $100 per kw. of capacity with estimated total production costs of 4 mills the plant, is being watched with exceptional interest.

Self-Liquidating Industrial Projects

Another development that offers much promise in the industrial field was the successful self-liquidating method by which the Jacob E. Decker[10] power plant was built. This plant, using two 450-lb. gas or pulverized coal fired boilers, a vertical steam accumulator, one extraction high back pressure turbine and one small condensing turbine superimposed on an old 150-lb. steam plant, is of excellent design. It was financed by an outside concern on a short term self-liquidating scheme which differs materially from the pay out of savings contract. Both the plant itself and the financing scheme are worthy of detailed study by all industrial enterprises using considerable power and steam.

[8]Use of Pulverized Petroleum Coke at Michigan City, Power Plant Engineering, p. 75, February, 1933.
[9]Edison Electric Institute Publication A7, August, 1933.
[10]A New Deal in Industrial Power Supply, Power Plant Engineering, p. 282, July, 1933.

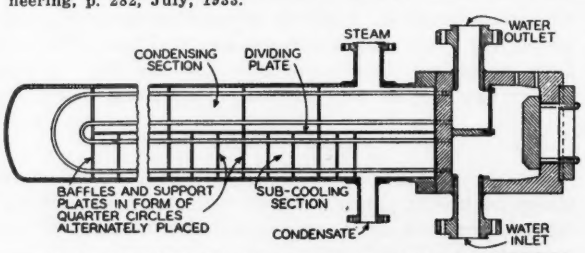
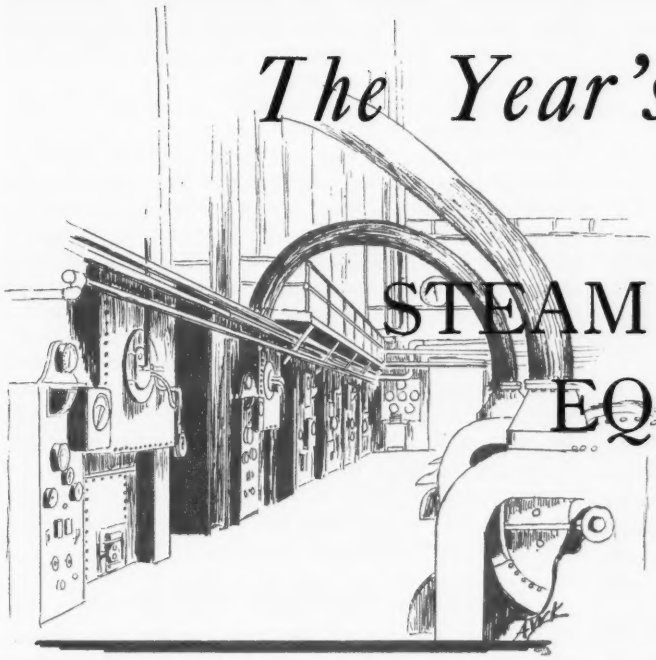


FIG. 3. DESIGN FEATURES OF THE 1600-LB. FORGED HEAD HEATERS FOR PORT WASHINGTON STATION

The Year's Development in STEAM GENERATING EQUIPMENT



SEVERAL THINGS have taken place during the past year that have changed the economics of steam generation and thus made necessary changes in equipment and methods. Power loads were still on a decline during the first third of the year in both industrial and utility power plants. As a result, only a few new power plants or extensions to old plants were undertaken. Manufacturers, however, have been busy, during the past few years, improving their designs and extending the fields of application, so that obsolescence in power plants is quite noticeable and with the delay in purchase of new equipment, which has been quite universal through the industry, the percentage of machinery that should be on the retired list but is still in operation is greater than ever before. Many factories have plans for new or remodeled power plants pigeon holed ready for contracts to be let and work to begin at the first indication of stable business conditions.

Competition Among Fuels

Considerable data on the technique of burning fuel has been added to the engineering literature of the day so that choice of equipment is possible without so much guess work as in the past. Coal, which has formerly been almost the universal fuel for power generation, is now meeting competition with oil and natural gas in many sections of the country. The conditions which have brought this about are, so far as the power plant is concerned, purely economic, i.e., choice is made of the fuel which will produce steam for the lowest cost to the plant. It has been the decreasing price of oil and gas delivered to the plant which has brought about this competition in fuels. With the construction of pipe lines from the oil and gas fields to the industrial centers of the country, transportation costs have been lowered and many plants are taking advantage of the lower fuel costs possible.

During the year several plants have been equipped to burn pulverized coal, oil or gas either separately or combined, as the price conditions at the time indicate is the most economical. Special burners to facilitate the change over have been developed for this purpose during the past year.

Stoker Capacity Range Increasing

Notwithstanding this competition with oil and gas, coal still furnishes three-fourths of the heat used in power plants and stokers are the most popular means of burning coal in boiler furnaces. Stoker capacities are being extended in both the higher and lower ranges, particularly the latter, several entirely new designs having appeared on the market during the past year. These designs are so perfected as to be entirely automatic in operation, making them highly attractive to the owners of one-man plants. The new designs that have come into the power plant field during the year all happen to be of the underfeed type ranging in capacities suitable for boilers of 500 hp. down. These stokers are adapted to the use of low grade fuels and, in the case of one stoker, mixed tan bark and coal is burned with entire success in an industrial plant.

Stokers in the higher range of capacities are undergoing changes in the details of design and considerable experimental work is being done by operating companies to improve the operation, wearing qualities and reliability of these stokers. Although zone control of combustion air has been used quite generally with traveling grate stokers beginning some 15 yr. ago, it is only within recent years that this system has been employed with underfeed stokers and this past year considerable progress has been made along this line several operating companies having run tests and established best draft pressures for their fuel and load conditions.

Preheated air for combustion was a long time in coming as a standard practice in power plants but the difficulties seem now to have been sufficiently overcome that the larger boiler installations find this provision quite essential. The early difficulties due to overheating of castings, warping and growth of stoker parts and rapid deterioration are being overcome by changes in details of design and employment of metals better suited for this service. Preheated air temperatures as high as 490 deg. F. are now being used without causing stoker troubles.

To secure better stoker performance more attention has been given to crusher rolls, maintenance of thin, uniform and rapidly moving fire beds, uniform air pres-

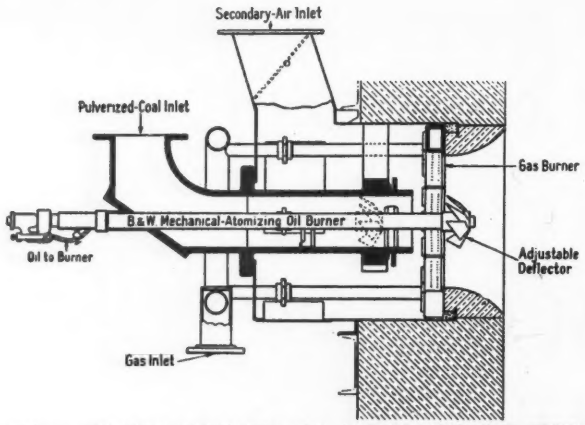


FIG. 1. BURNER DESIGNED FOR GAS, PULVERIZED FUEL AND OIL, USED SIMULTANEOUSLY, SEPARATELY OR IN ANY COMBINATION

sures and operation at reduced ratings. Some have found that they can reduce smoke and cinders by judicious use of overfire air. The air may be admitted at the rear or side walls which helps to keep down slag formation. The results of an investigation carried on at the Bureau of Mines and reported in the September issue, page 376, indicate that no great differences in efficiency are accomplished by changing slightly the comparative travel of the main and secondary rams of a horizontal underfeed stoker but marked improvement took place when firemen learned the proper manipulation in burning down refuse.

Combustion Control

Regulation of combustion control has received considerable attention and new equipment for this service has appeared on the market. One of these regulators is designed for small and medium sized boilers and employs a pilot valve spring to balance the required boiler pressure imposed on a pilot diaphragm and controls dampers, gas and oil firing valves, air inlet louvers, stoker draft fans, stoker steam valves and rheostat.

Another new controller has a master element that works from change in steam pressure but functions to restore the pressure to a constant value. Through impulses transmitted electrically the master controller regulates induced draft, fuel-air ratio controller, and furnace pressure controller.

At the Hartford Electric Co. plant a metering type of control has been reported as successfully meeting exacting service requirements. This control equipment is applied directly to the mill feeders and draft dampers. A supplementary action regulates fan speeds as required to keep the dampers within a predetermined range. A control-rheostat indicator corresponds to the desired boiler output. By means of this rheostat the valve of an electric control current acting on the fuel and air controller is fixed. These set up loading forces that must be balanced by proportionate check back forces representing the actual fuel and air supplies.

Lignite Burned in Suspension

In the art of burning lignite on chain grate stokers, quite a novel experiment has turned out successfully in the Kidder Station.[1] Here a short fire method is employed, practically all of the combustion taking place in one of the six draft zones of the stoker, usually the third zone, although almost equally good results have been obtained when using any one of the zones from No. 1 to No. 4.

The method employed is to force the draft in this one active zone to the point that practically all combustion takes place in this zone where the fuel is actually lifted from the grate by the force of the draft and the particles are burned in suspension. The draft pressure used ranges from 2 to 4 in. of water and the thickness of the fuel bed varies from 8 to 16 in. depending on load. It is reported that the boiler load can be raised from banked condition to 200 per cent rating in 15 min.

The shape of the furnace is such that the velocity of the gases decreases sharply in the upper chamber and the suspended particles drop out and return to the flame by gravity, so that little unburned carbon escapes with the gases. This method of firing leaves the rear section of the grate nearly bare and what unburned fuel remains can readily be burned by supplying the necessary air to the rear zone so that the fixed carbon left in the ash is proportionately low.

Developments in Burning Pulverized Coal

At South Amboy station has been developed a system of burning pulverized coal that is giving excellent results and deserves consideration in other plants. Serving each boiler are five unit pulverizers each serving a single burner. As these burners were constructed for

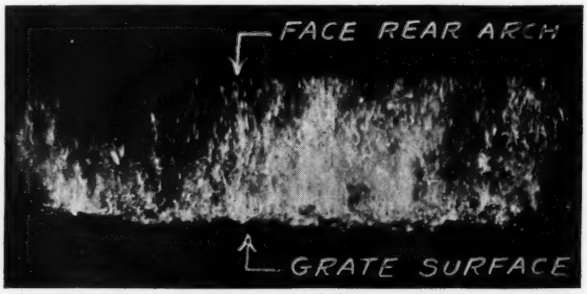


FIG. 2. BURNING PARTICLES OF LIGNITE IN SUSPENSION OVER TRAVELING GRATE

water cooling, no air is required for cooling when they are not in use and this feature permits cutting burners in and out of service with variation in load, thus enabling the engineer to work all but one of the burners in the furnace at their most efficient rating, the swing of the load being taken by only one of the burners in operation. The coal-to-air ratio is controlled manually with the aid of remote controlled valves and indicating lights, the quantities of both fuel and air being measured before they enter the furnace.

Weighing pulverized coal on its way to the burner has recently been made possible by the development of a tank which serves as a weighing hopper and is automatically filled and emptied by air pressure.[2] The transport line itself consists of standard pipe of the proper size for the particular installation. Once calibrated the number of dumps is an indication of the amount of fuel transported. One small plant reports that it buys powdered coal from a dealer who delivers it to the plant in paper bags all ready for delivery to the burner. This

[1] Power Plant Engineering, page 205, May, 1933.

[2] Power Plant Engineering, page 273, June, 1933.

scheme is thought by some to open a field for coal where oil or gas has been the usual fuel.

Lighting pulverized coal burners has on many occasions resulted in flare-backs that have been the cause of personal injury. A method used in the Hotel New Yorker was designed to avoid this danger. The gas torch used for this purpose is installed permanently in the coal burner and is ignited by two high tension spark plugs. A butterfly air-inlet check valve prevents backfiring of the gas. At Huntley No. 2 oil torches lit by high tension sparks are used for igniting the coal burners, the entire operation being accomplished by the press of a button.[3]

Smoke Abatement a Personal Problem

In the problem of smoke and fly ash abatement, progress seems to be slow. Engineers have developed furnace designs that, properly operated, will not emit objectionable smoke, but difficulty is encountered in securing the proper operating personnel. To overcome this difficulty a gas washing device has been developed for which some success has been reported though such practical difficulties as corrosion, draft loss and sludge removal are delaying its adoption. This not only removes the smoke but fly ash as well. The applications reported, however, have all been in small plants, so this method for large plants still lacks proof of its practicability for abating smoke and the electrostatic precipitator is favored here.

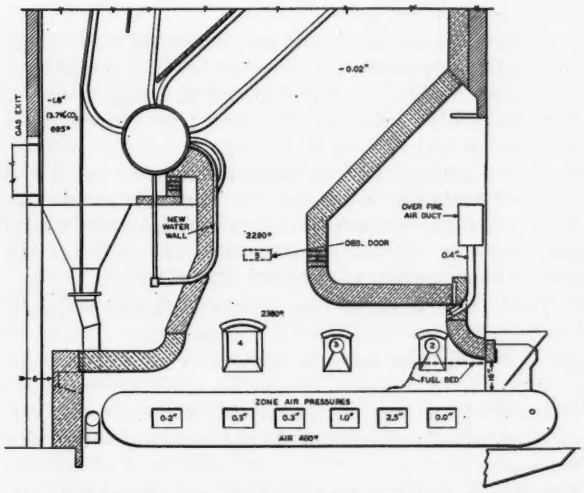


FIG. 3. FURNACE AT WASHBURN STATION FOR BURNING LIGNITE

Considerable research has been carried on at the University of Illinois on the problem of eliminating obnoxious sulphur compounds from boiler furnace gases. These have demonstrated the impracticability of using untreated water for this purpose but several salts of ammonia have been experimented with and are so promising that complete details for carrying out this process are being developed.

In testing out the practicability of pulverized petroleum coke as fuel for power boilers, the Michigan City Station reported[4] boiler efficiency of 87.92 per cent as compared with 84.5 per cent when burning coal in the same furnace. The advantages are attributed to less

[3]Edison Electric Institute Publication No. A6, 1933. Pulverized Fuel, page 15.
[4]Power Plant Engineering, page 75, Feb., 1933.

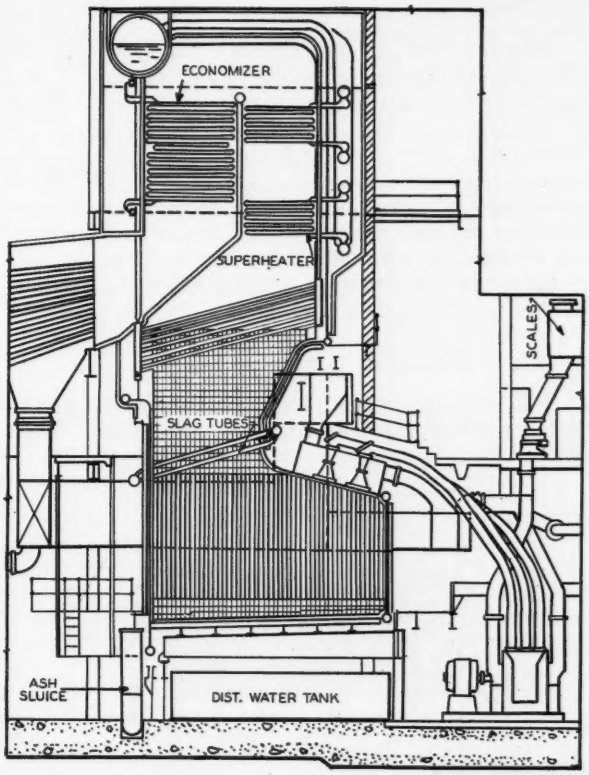


FIG. 4. SECTION OF BUZZARD POINT BOILER SHOWING SLAG BOTTOM FURNACE WITH SLAG TUBES AT FURNACE EXIT

slag, less dust on superheater, economizer and air heater tubes, lower flue gas temperature and less fly ash.

Oil Burning

In the field of oil burning, recent advancement has been principally in the development and improvement of commercial oil burners, several of which have been announced during the past year. The developments have had for their object better atomizing, wider range of capacity, adaptability of burners to greater variety of liquid fuels and combination burners for handling oil or gas or pulverized coal either singly or simultaneously.

The choice of fuel is governed almost wholly by the cost to the plant and transportation conditions have changed so greatly that many localities are given much wider choice of fuels than previously. Oil and gas pipe lines now radiate over wide areas from the oil fields and have placed these fuels in competition with coal in many power plants. Furnace and burner designs that permit changing without difficulty from one fuel to another as relative prices fluctuate are becoming more common. Even stoker fired furnaces are being designed so that the grates can be quickly covered with sand and refractory or removed temporarily to permit oil or gas burning.

In nearly all cases it will be found that the possible heat release per cubic foot of furnace space will be greater with oil or gas than with coal. Comparing oil and gas, it is reported that except on boilers with radiant type superheaters higher steam temperatures were secured with gas than with oil, while furnace temperatures were higher with oil than with gas.

Furnaces

Advancement in furnace design has been noted in slag tap bottoms for pulverized fuel. This type of furnace has several advantages, it reduces slag and clinker accumulation on tubes, makes ash removal simple and inexpensive, makes possible the use of fuel having a low fusion temperature ash and is low in first cost. These advantages have encouraged engineers to experiment with slag-tap furnaces and though results have justified the efforts made, a suitable refractory material seems to be lacking and this need is delaying more universal use of this type of furnace bottom.

Mercury Boilers in Service

Following ten years of practical operation of the mercury vapor plant at Hartford,[5] two plants using

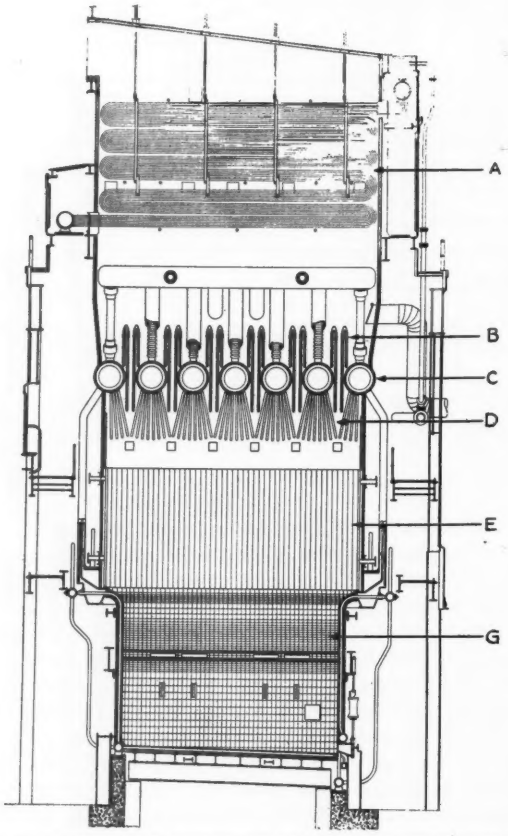


FIG. 5. SECTION OF MERCURY BOILER IN SCHENECTADY PLANT

A. Steam superheater. B. Mercury liquid heater. C. Mercury drum. D. Porcupine tubes. E. Mercury walls. G. Water walls surrounding pulverized fuel slag bottom furnace.

mercury-steam cycles have been placed in operation during the past year. One of these is at Schenectady, N. Y., and furnishes power for the General Electric Co.,[6] while the other is at Kearny, N. J., being a unit in the Public Service Electric Light & Gas Co.[7] system.

While the mercury boiler and turbine units in these two plants are similar in design, their arrangements in the plants differ quite widely, the Schenectady plant being of the outdoor type while that at Kearny is housed. Another feature of difference is that the mercury turbine at Schenectady is at the usual turbine floor level and the mercury is delivered back to the boiler drums by means of centrifugal pumps instead of by gravity in the other plants.

The mercury boiler in the Schenectady plant furnishes vapor for a 20,000-kw. turbine and 325,000 lb. of steam per hr. It is a vertical arrangement of heating elements consisting of a slag bottom pulverized fuel fired furnace surrounded at the bottom by a water wall and at the top by a mercury wall, the gases passing around the porcupine tubes, drums and liquid heaters of the mercury vaporizing element and up through a steam superheating element on their way to the air preheater and stack.

While the mercury vapor is generated at a pressure of 125 lb. per sq. in. the steam pressure generated by the water walls and the mercury condenser steam boiler is 400 lb. per sq. in., the final temperature after passing through the superheater being 750 deg. F.

One of the outstanding developments in boiler practice comes from Germany where the Benson boiler[8] has been so changed in design that it can now be operated at pressures below the critical pressure of steam. Not until recently was it definitely determined that the tube failures which occurred in the first Benson boilers were due to salts contained in the feedwater. It was discovered that failures occurred in the zone of conversion of water into steam which is only a small portion of the boiler heating surface.

With this fact known, the trouble has been overcome by placing this zone in a range of lower flue gas temperatures. Now it is possible to deliver steam of almost any pressure at practically constant temperature. This new design makes possible the operation of a turbine, served by a single boiler, without a throttle valve, the required variation in pressure to meet load conditions being controlled by the rate of evaporation. This feature simplifies the turbine construction and reduces the energy consumption of the feed pump.

In the field of boiler operation, the photoelectric cell has been introduced and bids fair to displace many of the old principles used in the design of instruments, because of convenience, reliability, and in some cases economy of first cost. As smoke indicators photoelectric cells have gone well beyond the experimental stage. The principles of electronics are also being used to indicate and control water levels in boilers[9] and one of the most interesting applications is that on the 3500-lb. experimental steam boiler at Purdue University where thyratron tubes are used to control the opening of the fuel oil throttle valve and the position of the boiler feed pump rheostat. Another more recent application is in the automatic control of feedwater treatment. The field, however, has barely been touched and many more applications are sure to become common practice.

Boiler Corrosion

Some interesting reports on the causes and inhibition of boiler corrosion have come from the German Government Material Testing Bureau. Tests indicated that in inclined tube boilers corrosion occurred at the upper ends of the top tubes and was attributed to the trapping

[5]Power Plant Engineering, page 263, June, 1933.
[6]Power Plant Engineering, page 354, August, 1933.
[7]Electrical Engineering, page 496, July, 1933.
[8]Power Plant Engineering, page 878, Sept., 1933.
[9]Power Plant Engineering, page 295, July, 1933.

of steam in these particular rows and as a result of these investigations the statement is made that the fundamental requirements for boiler circulation is that the strongly heated tubes should have a definite upward circulation while tubes in which water flows downward should not be heated or should be heated very slightly so that they, in effect, form an economizer rather than a boiler section.

Considerable attention has been given to the problem of pitting in stand-by boilers among central stations in the New England district.[10] Serious corrosion does exist but is not prevalent; pitting, however, is quite common but is confined almost entirely to drums. Protective paints are commonly used with fair results but they are not considered 100 per cent effective. Some operators blame free oxygen in the water as the only corrosion agent that gives trouble and make a practice of using only oxygen free water in stand-by boilers. Others consider that the only certain way to prevent pitting and corrosion in an unused boiler is to draw off all the water, dry it out and keep it ventilated.

Considerable attention is being given at the present time to the causes and prevention of slag accumulation in boiler furnaces and on tubes. In normal operation it is recognized that the need for external cleaning of the boiler is the most prevalent cause for boiler outage. The character of the coal and the method of firing are two primary factors in the slagging problem, coal having ash with low temperature fusability and pulverized coal firing being the most common offenders. These conditions, however, can be greatly benefited by a properly designed furnace, maintaining low furnace gas velocities and keeping the combustion rate below the allowable maximum for the particular fuel, furnace and boiler conditions.

In pulverized coal furnaces, it has been learned, when the tip of the flame where gas is still being burned enters the tube bank, slag is almost certain to be formed, regardless of the character of the coal used. The remedy for this is to shorten the flame, cool the ash particles below the slagging temperature or move the tube bank, each of which has been found effective in recent practice. Two methods of shortening the flame length prevail, one is provision for causing turbulence of the flame, the other is employing preheated combustion air. Slag on tubes may also be reduced by the use of slag tap furnaces, especially when the flame is directed against molten slag, or the provision of a water screen for the furnace bottom. The Buzzard Point boilers in effect combine these provisions by placing the slag tubes between the furnace and the boiler proper.

In stoker fired furnaces carefully placed overfire air jets to give turbulence to the flame and the use of preheated combustion air are found to be effective methods of reducing slagging.

As no 100 per cent method of preventing slagging has been found, considerable study is being given to the best methods of removing the accumulation. The most common and effective method of doing this while the boiler is in operation is by means of soot blowers, either hand lances or mechanically operated nozzles using steam, air or water.

Several manufacturers have announced new boiler designs during the past year that have been developed as standard products to take the place of small obsolete boilers. These for the most part, are of the water-tube type designed to occupy the space of h.r.t. boilers but to increase the steaming capacity several times. They are complete units including stoker or burner, furnace with water cooled walls, boiler proper, superheater and economizer section incorporating the principles of design found by practice to be the most desirable. And

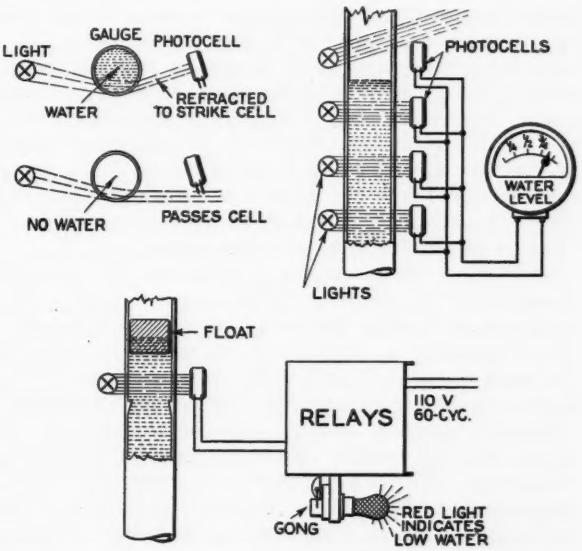


FIG. 6. THREE DIAGRAMS ILLUSTRATING METHODS OF INDICATING AND CONTROLLING WATER LEVEL BY MEANS OF ELECTRIC EYE

for real small installations electric steam generators have been developed principally for use in industrial processes.

Water Purification Studies Continue

During the past year Professor F. G. Straub has been studying the formation of calcium-sulphate scale at various pressures and the amount of sodium carbonate necessary to prevent scale of this character. Likewise R. E. Summers and S. C. Keevill are reporting to the A.S.M.E. their findings in experiments with silicate impurities in boiler waters and how deposits can be prevented or materially reduced. Meanwhile the Joint Research Committee on Boiler Feedwater Studies is continuing its experimental work on the behavior of solids in boiler water and S. J. Meisenburg and C. H. Fellows are continuing their comparisons of methods of determining the dissolved oxygen in feedwater.

As an aid to the operator two automatic zeolite water softeners have made their appearance in the field. One of these is controlled by the water meter reading, i.e., regeneration takes place when a definite amount of water has passed through the filter and regeneration is stopped when a predetermined amount of brine has been used. This cycle is repeated automatically according to the meter readings. The other purifier employs a photoelectric cell to operate the regenerating valves when the treated water indicates that regeneration is needed and close them when regeneration is completed. This is done by passing a beam of light through a continuous sample of the water, the transparency of which varies with its purity and thus causes the electric eye to function.

[10]Electrical World, page 189, Aug. 5, 1933.

PRIME MOVERS Improved by

DEVELOPMENT of modern steam turbines has become directed toward the perfection of details of design and selection of the most suitable materials. Steam pressures and temperatures continue to increase in general practice and with this increase comes the need for modification in the design of turbines which is being met by manufacturers. Two classes of turbines are at the present time receiving the greatest amount of attention in design. These are condensing turbines of the maximum possible capacity rating for a given rotative speed and the high pressure, high temperature non-condensing turbines to be superimposed on existing generating units in older plants.

Since 60-cycle generators have become the standard throughout the country, turbines are limited practically to two speeds, 1800 and 3600 r.p.m., corresponding respectively to 4 or 2 pole generators. As a rule the most economical unit is the one that runs at the higher speed, the advantages being improved thermal efficiency, reduced weight, greater convenience of operation and smaller investment in building and foundation. With the recognition of these advantages, designers have been active in the development of the higher speed units which are now being installed in power plants.

Exhaust end bladings due to physical limitations have held down the capacities of turbine units but these have been so improved that single cylinder turbines with single exhaust blading groups are now built in capacities of 15,000 kw. and 80,000 kw. respectively for speeds of 3600 and 1800 r.p.m. and it is reported that turbines of this type can be made for capacities of 17,500 and 90,000 to 100,000 kw. when operated at high vacuums.

Improvement in the exhaust end blading design has been delayed by the lack of suitable metal for use in these blades which are subject to severe physical strains as well as erosion. Stainless steels are now commonly used for this purpose, a 12 per cent chromium alloy having a tensile strength of over 100,000 lb. per sq. in., yield point 80,000 lb., elongation 18 per cent and reduction 40 per cent are now available and meeting with favor among designers.

The policy adopted by turbine purchasers in this country seems to favor the use of high blade velocities in order to decrease unit weights and dimensions and simplify design and operation. This policy makes the erosion problem more difficult but this is being solved by the use of more suitable metal in the blades and limiting the moisture in the exhaust steam to 12 per cent. This is accomplished by increasing the initial steam temperature and removing the moisture from the exhaust groups of blading by mechanical means.[1] Leaving losses vary greatly in practice, being from 0.91 to 3.96 per cent at the most efficient load with the average value about 2 per cent, at full load the average leaving loss is about 4 per cent.

Another loss in efficiency of turbines is due to the accumulation of scale deposit on the blading which is traceable to the impurities in the feedwater and several methods of combating this difficulty are in use among operators.[2] As a rule the deposits are removed by washing the blading with feedwater or by passing wet steam through the turbine while it is kept slowly revolving. Experience has shown that frequent starting and stopping of the turbine will in many cases furnish sufficient moisture to keep the blades clean. A method recently developed for washing the steam as it leaves the boiler on the way to the superheater has been used with success in not only reducing scale on the turbine blades but preventing the fouling of superheater tubes.

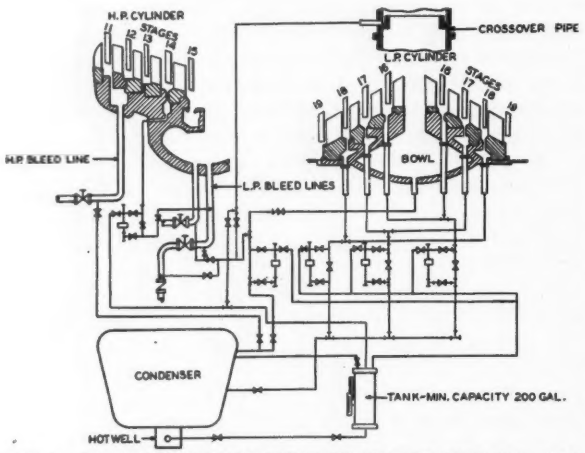


FIG. 1. DIAGRAM OF MOISTURE DRAINS IN HUDSON AVE. TURBINE WHICH WAS USED IN INVESTIGATION OF MOISTURE REMOVAL PROBLEM

Exhaust Steam from Auxiliaries Used by Turbine

Turbines of the extraction type continue to grow in favor, extending their application particularly in industrial plants where flexibility of pressure simplifies many of the steam problems and is effective in bettering the overall economy of the plant. An unusual provision is noted in the design of the Kidder station where four stage extraction is employed.[3] Here any excess of exhaust steam from the extraction heaters and boiler feed pumps is returned to the turbine through the low pressure No. 4 bleeder connection. This connection is under automatic control both from the exhaust pressure and also from the turbine throttle to prevent backing up of steam when the unit is shut down.

In connection with steam turbine development, interest is attracted to a new system of steam storage that has been developed in Europe by Dr. F. Marguerre.[4] Water vapor, and consequently heat, is withdrawn by means of a turbine compressor driven by surplus energy, from a water storage reservoir at a lower temperature level, compressed and condensed in

[1]Edison Electric Institute Publication No. A3, Turbines.
[2]Power Plant Engineering, page 304, July, 1933.
[3]Power Plant Engineering, page 113, Mar., 1933.
[4]Power Plant Engineering, page 426, Oct., 1933.

d by Perfection of Details

an upper water storage receiver which stands at a higher pressure. This upper accumulator is then discharged through a steam turbine producing peak load in the usual way, the exhaust steam being condensed into the lower reservoir, returning to it the same amount of heat as previously withdrawn. The cycle then begins again.

Reciprocating Steam Engines

Steam engines of the reciprocating type have not shown any marked change in design but are favored

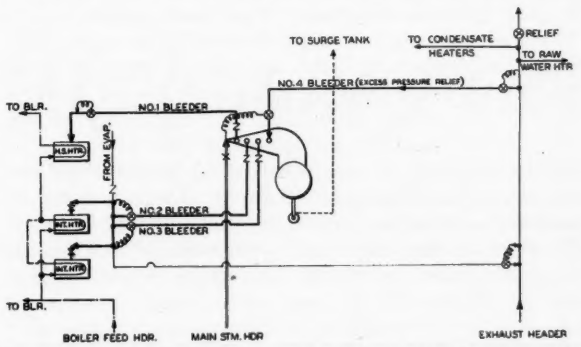


FIG. 2. AT KIDDER STATION, EXCESS EXHAUST STEAM IS RETURNED TO TURBINE THROUGH FOURTH BLEED STAGE CONNECTION

by many engineers for industrial plants that have use for low pressure exhaust steam, where units of less than 500 kw. capacity fit into the load requirements, uniflow types being popular, where direct connected generating units are desired. With the legalization of the sale of beer, brewery power plants have been undergoing modernization and some new plants built. For this class of service engineers have retained a preference for reciprocating steam engines although turbines are not out of the picture in the larger plants.

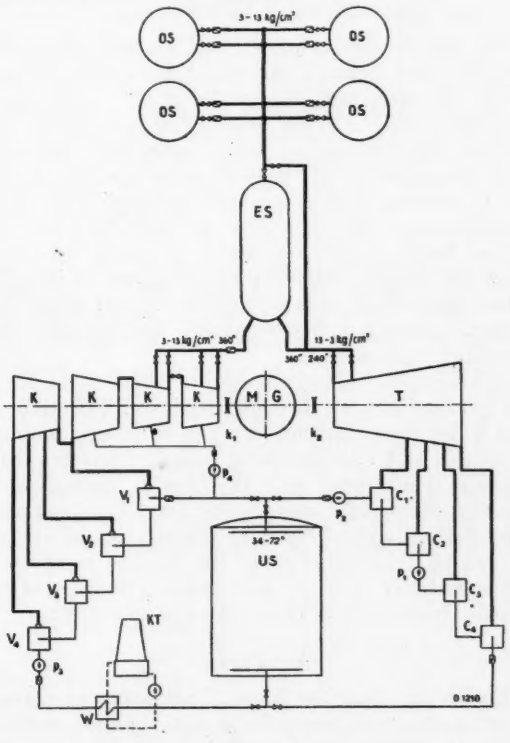
Several newly designed small engines employing new metals, improved bearings and lubricating systems have appeared on the market for such service as stoker drives, fan drives and other auxiliary service.

Some thought is being given to the use of a combination of Diesel and steam engines in which steam will be generated by the heat of the jacket and exhaust gases from the Diesel engine. A notable example of this practice is the plant of the Pan Corp. in the Stock Yards district in Chicago.

Largest American Diesel Plant

In the field of the Diesel engine, the outstanding installation of the year, in fact of several years, was at Vernon, Cal., where five 7000-hp. units,[5] the largest ever built in America, were installed, making the total capacity of the plant to surpass all other exclusively Diesel plants in the world except one in Shanghai. These engines are Hamilton M.A.N. type units, each made up of eight double-acting two-cycle cylinders with a bore of 24 in. and stroke of 36 in., the speed of the shaft being 167 r.p.m. and the rated brake horsepower 6850. Pistons are designed for water cooling made up of an upper steel forging, a lower steel casting both bolted to a shoulder on the rod; below the upper section is a cast-iron ring guide and above the lower section is a cast-iron skirt. The unusual features of the plant include forced draft spray-nozzle cooling towers, continuous lubricating oil purification, scavenging air supplied by blowers and waste heat boilers for steam generation.

Many other Diesel installations have been made throughout the country, the popularity of this type of prime mover being greatest in the municipally owned plants of small cities and villages. The activity in the construction of these plants has been augmented by the policy adopted by the federal government in making outright financial gifts and loans on easy terms to communities undertaking such public works. Diesels are also finding increased service in office buildings with the development of waste heat reclaiming equipment. Industrial plants, also, look with greater favor on Diesel engines as their reliability is being increased by the perfection of details of design and the development of dependable auxiliary equipment.



MG Motor and generator
k_1, k_2 Movable couplings
K Compressor
T Steam turbine
OS Upper storage reservoir
ES Superheat accumulator
US Lower storage reservoir
V_1—V_4 Evaporators
C_1—C_4 Condensers
KT Cooling tower
W Heat exchanger
p_1—p_4 Pumps

FIG. 3. HEAT STORAGE SYSTEM FOR STEAM TURBINES

[5]Diesel Power, page 614, Oct., 1933.

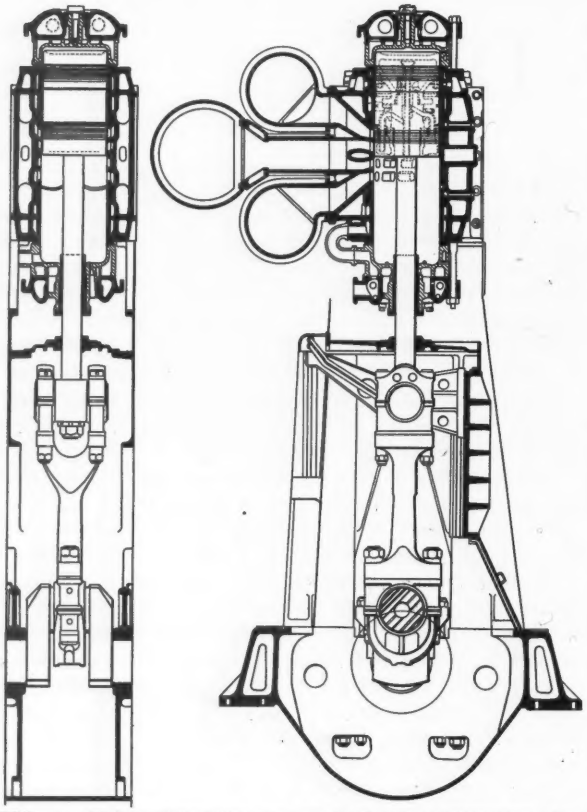


FIG. 4. CROSS SECTION OF THE DIESEL ENGINES AT VERNON

During the past year a great amount of research work has been done on various phases of Diesel engine design and operation, the results of which are sure to have their effect on the practice of the future. For example, the welding of steel frames and plates used in the manufacture of Diesel engines is a new practice that is meeting with favor after undergoing thorough scientific investigation in both the laboratory and commercial fields. Speed regulation, a feature of Diesels which has limited their field, has been greatly improved to the point where it is thought to exceed other types of prime movers with comparable flywheel effect and governing equipment.

Considerable advancement has been made in the fuel burning system through studies of injection systems which have resulted in a better understanding of the causes and elimination of knocks. Supercharging is being investigated with the idea of increasing the capacity of engines already in service. Research is being carried on to determine the relative amounts of heat which are dissipated to the various parts of the engine cylinder, also the mechanism and rates of heat transfer from various types of radiating surface.

Condensers

Following along the lines of development noted in recent years, condensers have not changed radically in design. Fusion welded steel shells, however, have been used successfully in the construction of condensers and are likely to become general practice, the 60,000 sq. ft. condenser at Kearny being of this type. For large units the single-pass type of condenser seems to be favored, as is also the practice of rolling the tubes in the tube sheets at both ends.

Considerable study is being given to the means for keeping the surfaces clean, chlorination being favored for preventing the growth of algae and slime accumulation. Considerable valuable information on condenser performance was contained in the report, made by J. N. Landis before the A.S.M.E. of tests conducted on two 101,000 sq. ft. condensers in the Hudson Ave. Station, the largest single-pass condensers now in service. From the results obtained the cleanliness ratio was determined by the Harding and Cooper method.

Belgian Gas Engines

A somewhat novel power station has lately been constructed by the Société Cockerill, of Seraing, near Liege, Belgium, for the iron and steel works of the Société d'Ougrée-Marihaye. The plant comprises two 7000-kw. gas engines with flywheel alternator, four waste heat boilers utilizing the exhaust gases from the gas engines and a 2500-kw. turbo-generator set in which part of the steam is utilized, the remainder of the steam being employed for operating turbo-blowers.

Waste heat boilers were constructed by the Etablissements Jacques Piedboeuf, of Jupille, Liege, and are installed in the open air as shown by the photograph. They are of the horizontal type, each with a heating surface of 4305 sq. ft., the four being capable of generating 45,500 lb. of steam per hr. at a pressure of

VIEW OF THE WASTE HEAT BOILERS INSTALLED OUTDOORS

213 lb. per sq. in. Gases enter the boiler at about 1250 deg. F. and leave at about 260 deg. F.

At its most economical load, the total net power is 8510 kw.-hr., representing a heat consumption of about 9500 B.t.u. per kw.-hr. or a heat recovery for the complete plant of about 36 per cent. On this basis M. H. Lesueur, of the Cockerill Co., in describing the plant and tests in the *Revue Universelle des Mines* claims that where blast furnace gas is available in large quantities 60 per cent more electric power can be generated by gas engines and waste heat boiler plants than would be the case if the available gases only were used in a complete steam operated plant, this figure being based on a heat consumption of about 15,000 B.t.u. per kw.-hr. for a modern steam plant of the same size.

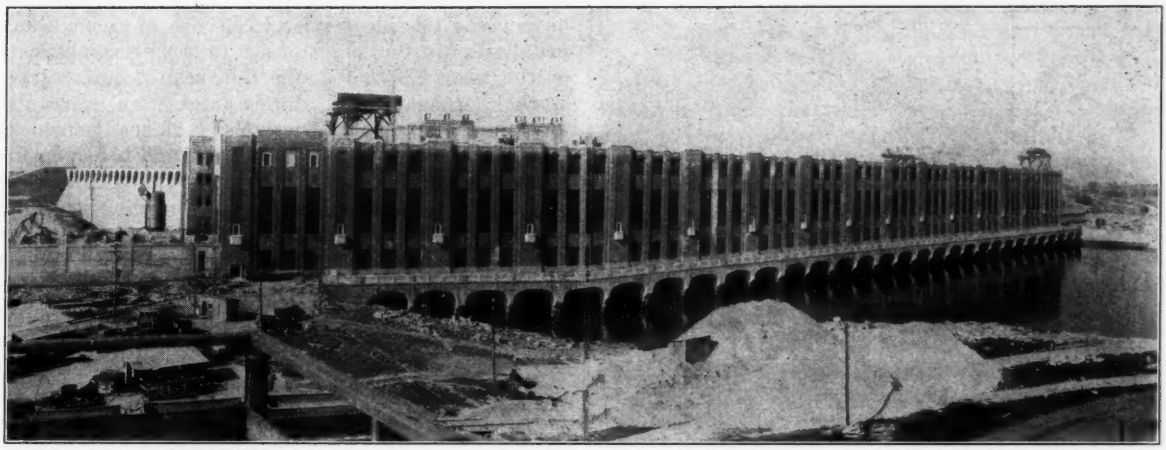


Photo. W. S. Lee Engineering Co.

Hydraulic Power Practice in 1933

THE YEAR 1933 was rather an unimportant year insofar as hydraulic power development was concerned, particularly as related to new construction. Few new plants were placed in operation and there were no startlingly new developments in practice or equipment design. Progress has been mostly in directions laid down by certain developments several years ago. While a number of plants using Kaplan turbines are in operation, the probable future trend with regard to the type of propeller turbine that may be preferred for low head plants is not yet clear. Kaplan turbines were installed in previous years at Safe Harbor, Lake Walk and other plants in this country and their operation apparently has been quite successful, but the use of Kaplan turbines for low head plants is by no means universal. Manually adjustable blade turbines at the Rock Island plant on the Columbia River and fixed blade turbines in the Chat Falls plant on the Ottawa River share honors with the Kaplan units in representing low head hydroelectric practice in America. It is too early to make any predictions in regard to probable future practice in this direction. It is true the Kaplan turbine has been used much more widely in Europe than in this country but since its introduction here comparatively few new projects have been constructed and it is possible that it will find much wider acceptance as times goes on.

The same is true of "pumped storage" developments—these also are much more numerous in Europe than in America, but the possibility of regenerative pumping at the Safe Harbor plant by means of the dual use of the same unit as a turbine and a pump has been investigated recently and this may open up a new field of development. Turbine manufacturers have developed runners suitable for such dual use and the electrical problems incident to reverse operation at either a similar speed or a dual speed appear possible of ready solution. In the few installations involving pump storage in American practice, motor driven pumps have been installed entirely separate from the turbine generator, although both pump and turbine are connected to the same penstock.

In Europe the practice usually has been to use a single electrical element either as a generator or motor with a permanently connected turbine on one side and a clutch connected pump on the other. Some interesting pump storage projects have been completed recently in Europe and others are under construction. Details of several of these will be described further on in this article.

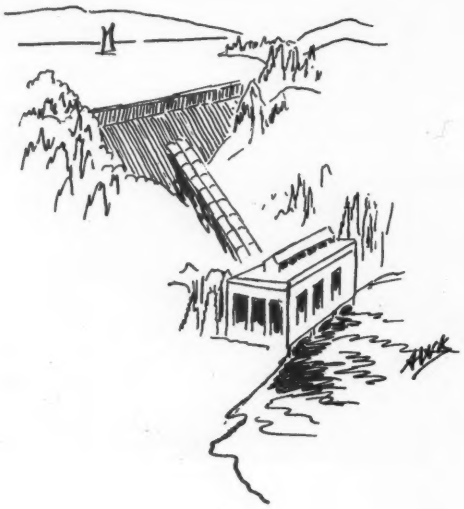
Investigations and Research

Despite the decreased construction activity there has been considerable interest and activity in the theoretical aspects of hydraulic development. Such troublesome problems as cavitation and water hammer are being given renewed attention and more accurate methods of measuring water flow are under consideration. It seems that in this particular branch of the art there is room for considerable improvement, for although the present methods of measuring flow are very much better than anything we have been able to devise thus far, they are by no means perfect, indeed the best method of measuring water flow cannot be compared to even crude methods of measuring electricity flow. The several methods in use are complicated and require extreme care in their use. What apparently is necessary is an entirely new method, a method involving new principles—probably an electrical method.

New materials and new methods of construction have been introduced in several branches of the field. In this phase of development may be classed such things as arc welding of steel penstocks and the use of stainless steel for buckets of impulse wheels, as well as for the orifices and needles.

Cavitation research, which received notable attention because of the excellent work of Prof. Wilhelm Spannhake at the Massachusetts Institute of Technology, has been continued and there are now several commercial and institutional laboratories in the United States which are equipped for making cavitation tests on model runners.

Perhaps the most outstanding event of the year in the hydraulic field from a technical standpoint was



the symposium on water hammer arranged by the American Society of Mechanical Engineers at Chicago during Engineering Week at A Century of Progress. This took the form of the presentation of a series of reports and papers on the theory and practical aspects of water hammer so as to make available to American engineers data and information which heretofore had not appeared in English before. It had been recognized for a long time that although many valuable contributions had been made on the subject of water hammer, many of them had never adequately been covered in the English language.

It was the purpose of this symposium to collect and correlate such material and together with other important data present it to American engineers. The material presented at this symposium aside from the discussion contributed at the meetings is contained in a 90 page booklet. It begins with a brief history of the theory of water hammer together with an extensive bibliography of the subject which is followed by a resumé of theory of water hammer in simple conduits. This is followed by a paper on the simplified derivation of water hammer formula and another most comprehensive paper on high head penstock design. Remaining papers deal with computation of water hammer pressures in compound pipes, the effect of surge tanks on water hammer, surge control, and water hammer tests at Croton Lake. In all this is a most complete treatise on the subject and it was received with great enthusiasm by all engineers attending the meeting.

The discussion of High Head Penstock Design was unusually comprehensive. As. Mr. A. W. K. Billings of the Brazilian Traction, Light and Power Co. pointed out, the accidents which occasionally happen at high head penstocks indicate that the design of these is not on a satisfactory basis. Information regarding these accidents is meager, but studies of such data as are available indicate that the dangerous surges causing accident nearly always result from some emergency condition not considered by the design and that the resulting pressures are usually considerably greater than would be calculated by accepted formulas and vary along the penstock in a manner very different from that commonly used as the basis of design. Eight years ago in initiating an important Brazilian plant the first two penstocks were designed on conventional lines and have given reliable service. The size of the ultimate installation in this plant of six to ten penstocks, each costing some $300,000 at the European manufacturer's works, without freight, duties or erection, warranted an extensive study of the design of high head penstocks. The paper presented by Mr. Billings and his associates is the result of this study. It included practicable methods of design, the data obtained regarding accidents and extreme surges in practical operation, the importance of accidental conditions, the mathematical theory of surges, the importance of partial and diffuse reflections usually ignored, complete tests of full size pipes and the hydraulic and mechanical details of design. These studies are continuing but the results already obtained were discussed in the paper.

Plant Developments

Although no new hydroelectric projects of importance were started this year, several plants started in previous years were completed and construction work on others continued. Among the latter group in this country the Boulder Dam project is easily the most important, first because of its magnitude and second because of its political-economic aspects. Work on this project has been progressing at a rapid rate during the year. The initial installation is scheduled to be placed in service in 1937. Construction of the power plant was started early this year and since then construction has been kept well up to schedule. The actual pouring of the concrete for the dam began during the second week of June and has continued practically without interruption since.

This project has received so much publicity that it is unnecessary to describe its details here but a few features regarding recent construction developments are of interest. The project is so large that many ordinary details require special attention. The amount of concrete necessary to build the dam, for instance, is so enormous that one can hardly conceive it. It amounts to more than 7,000,000 tons. To pour this amount of concrete and to set it properly require unusual methods of handling and special attention in setting. Concrete when left to itself rises about 40 deg. F. above its temperature when laid. Ordinarily this does not make any difference but with such huge masses as are involved at Boulder Dam, this results in a great amount of heat which unless dissipated by artificial aid would result in dangerous strains and cracks. If no means were taken to get rid of this heat, it would require centuries to cool off. To cool off the concrete, therefore, a special refrigerating system has been installed. Two inch iron pipe, spaced 10 ft. apart vertically and 11½ ft. horizontally, is being installed as rapidly as the concrete is poured. Cold water is circulated through these pipes constantly to reduce the temperature. Experiments which led to the inclusion of this cooling system in the dam were conducted in the Owyhee Dam in eastern Oregon. Here the concrete rose to a temperature of 118 deg. as it set. Pumping water through the pipe at 64 deg. reduced the temperature of the concrete to 84 deg. in two weeks.

Another feature of interest at Boulder Dam is the construction of the pipe for the penstocks. This is being fabricated at the site of the dam because the finished

sections are too large to be transported by railroad. For this purpose, a 520 by 90 ft. fabricating plant has been erected fully equipped to fabricate by fusion welding and to test by X-ray, 14,500 ft. of pipe, 8½ to 30 ft. in diameter, from steel plate ranging in thickness from ⅞ in. to 2¾ in. Approximately 400,000 linear feet of welding will be performed in the fabrication of all pipe sizes. As pointed out in the article on electrical developments, the generating units at Boulder Dam will be the world's largest, both electrically and physically. Work on these units was started several months ago.

The Beauharnois Development

Though completed in the fall of last year, another hydraulic project in this country which received considerable attention this year was the initial installation at the Beauharnois development on the St. Lawrence River. This project, shown at the head of the article, is of interest in more ways than one. Development of the power resources of that portion of the St. Lawrence River which forms part of the boundary between the United States and Canada for many years has been studied by engineers and talked about by politicians and neither the end of the discussion nor the start of construction is yet in sight. Yet while politicians have been arguing, a project equal in output has been begun and the initial installation placed in service. This station, located within 25 mi. of Montreal, when completed will be the largest hydroelectric station in the world, as provision is made for an ultimate installation in generating capacity of 2,000,000 hp. The present power house, approximately 1100 ft. in length, is designed for fourteen 50,000-hp. generating units and two 7800-hp. station service units, and is capable of extension for the maximum of 42—50,000-hp. units required for the utilization of the entire main river flow. Two 7800-hp. service units and two 50,000-hp. 60 cycle main units are now in operation. To meet the present power contract requirements two additional 50,000-hp., 60 cycle units and four additional 50,000-hp., 25 cycle units are to be installed prior to October, 1937.

Of considerable interest in connection with this project is the power diversion canal through which the water for the plant is drawn. This canal is 15½ mi. long and extends across the relatively flat country between Lake St. Francis and Lake St. Louis. Much of the canal area is below the level of the upper lake, consequently the canal is carried between dikes for its entire length. At the Lake St. Francis end the dikes are low, increasing gradually to a maximum height of 45 ft. near the power house forebay. For the present initial installation only part of the ultimate channel is excavated below ground line; as additional water diversion is required the channel will be dredged accordingly. The power required for this additional dredging will be supplied by the plant itself.

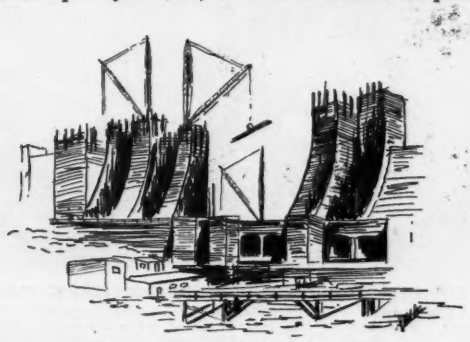
In Europe a number of important hydroelectric projects are in course of development. There is, for example, the scheme of development on that portion of the Rhine between Germany and Switzerland. In a length of 85 mi. the river has a total drop of 520 ft. This head will ultimately be utilized by 13 developments of which 6 are built.

In northern Germany, the Schluchsee project now in course of construction presents an interesting feature in that a pump storage arrangement compensates for power fluctuations in two different hydraulic areas. This project is situated on the southern edge of the Black Forest and utilizes water from the Feldberg district where precipitation is high. It is in the state of Baden in which the water power resources are made up of the water power of the Rhine, of the Black Forest rivers, of the Neckar and of the Main. In summer time there is a great increase in the flow of the Rhine and the greater part of this surplus water cannot be utilized. In winter, on the other hand, the water is very low. In the case of the Black Forest rivers conditions are just reversed, in winter time the flow amounts to ⅔ of the total annual flow. In view of this, the best solution appeared to be to use the water power of the Black Forest in power stations with storage facilities which would supplement the power station on the Rhine. The Schluchsee installation thus fulfills two different functions. On the one hand it compensates the fluctuations in power supplied by the Rhine and on the other hand it utilizes the surplus energy from the Rhine for pumping water into the Schluchsee storage reservoir. The first part of the construction program has been completed and work is under way on the remainder.

Another project somewhat similar to this, though it does not involve pump storage, is the Oberhasli hydroelectric development above Meiruiger in the Bernese Oberland in Switzerland. The first step in this project was completed the latter part of last year but much remains to be done and further construction is in progress. Here again seasonal storage plays a part. Since about 95 per cent of the natural flow of water from the Bernese Oberland takes place during the six summer months it was necessary to create huge storage basins. Nature offered very favorable conditions in this respect so that it was possible to create two large artificial lakes, the Grimsel Lake and the Gelmer Lake with a capacity of 3.5 billion and 450 million cu. ft. respectively.

A number of important government and government aided hydroelectric developments are under way or planned for the very near future in this country. Among these is the Granite Canyon project near Rawlings, Wyoming. This calls for an immediate installation of 18,000 kw. with an ultimate capacity of 51,200 hp. Bids will be called for next spring.

On the Columbia River in Washington actual work on the Grand Coulee Dam has begun. This project involves generating capacity to the extent of 700,000 hp. Work has begun on the Bonneville Dam 40 miles up the Columbia River from Portland, Oregon. This will be the first federal power project on the Columbia. An initial installation of 90,000 kw. is planned while an ultimate capacity of 540,000 kw. is said to be possible.



POWER PLANT ENGINEERING December 1933

Application *of* New Principles M

Application of New Principles Cause Renewed Development in Many Branches of the Electrical Art. Vacuum Tubes, Rectifiers, Photoelectric Principles, etc., all Instrumental in Directing the Trend of Progress in the Field.

ANY ATTEMPT TO REVIEW in the space of a few pages the year's developments in the electrical industry, even in these days of reduced output, is an ambitious endeavor. For developments in this field are so numerous, so diverse and have so many ramifications that even to list them all, without saying anything about them would require several paragraphs. So in this article we must necessarily confine our discussion to those developments which are of outstanding importance, particularly to the power plant industry, though we will touch upon others. In the electrical field, the trend of development that is most significant is the increasing application of the thermionic tube, not to mention the constant development of these devices themselves. Only a few years ago the number of tubes commercially available numbered perhaps about a dozen. Today the R.C.A. Radiotron tube manual lists around a hundred, but these do not include scores of other tubes for special purposes. The vacuum tube is a marvelous device. Although it appears to be a fragile affair, constructed of metal and glass, in reality it is a rugged instrument that makes possible the performing of operations, amazing in conception, with a precision and certainty that is astounding. It is an exceedingly sensitive and accurate instrument, and its future possibilities, even in the light of present day accomplishments are but dimly foreseen, for each development opens up new fields of design and application.

Another field in which the application of electricity is increasing at a startling rate is in the chemical processes. This subject was the basis of an extremely interesting paper[1] presented this year before the American Institute of Electrical Engineers by Colin G. Fink and in which he predicted that in another 10 yr. the electrical power consumption for the electro-chemical industries will be at least 30 billion kw-hr. per yr. or about 1/3 the total power generated in the United Stases today.

[1]Electricity in the Chemical Processes. Published in "Electrical Engineering" for March, 1933, page 151.

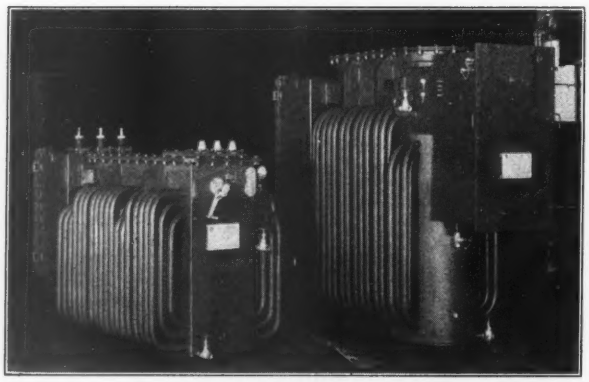


FIG. 1. USE OF PYRANOL REDUCES SIZE OF UNITS
These are two 500 kv.a. 27,060/216/125 v. secondary network transformers. The one at the left is filled with Pyranol, the one at the right is oil filled. (Photo, courtesy General Electric.)

Developments in the field of electrical communications need scarcely be mentioned here. Each day brings new improvement in this field, both in service as well as in a more efficient use of materials and labor. This year perhaps the most notable achievement in the communication art was the demonstration before a critical audience at the Academy of Music in Philadelphia of a new system of sound transmission developed by the Bell Telephone Laboratories. This system accomplished three elements all of which are necessary for the faithful reproduction of sound. The first of these is what is called "auditory perspective"—creating the impression of an invisible orchestra grouped as it actually is at some distant point. The second is the faithful reproduction of music from the lowest to the highest pitch, and third is the range of volume from a barely audible whisper to a din that no ear can endure.

These developments in communication may seem far removed from those in electro-chemistry or in power generation and distribution, yet such is the state of the art today that developments in one influences the other. The vacuum tube, as is well known, was developed primarily for the radio communication field, yet only a few months ago in a station of the Scranton Electric Co. at Scranton, Pa., a new synchronous condenser was installed using vacuum tubes to supply excitation. Not only that, but in Boston, in the Salem St. Substation, the vacuum tube has replaced not only the exciters, but all the synchronous converting equipment as well. This installation has been operating now for practically a year. It is because of this interrelationship in the application of fundamental principles to various branches of the art that developments should be considered broadly. For this reason a new development in the communication field should be of interest to, say, the power engineer—the principle involved may be useful in his own work.

Synchronous Machines

As has been the case during the past few years, most of the development in generators, motors and converters has been in the improvement of details of design and manufacture. Progress has been made in high voltage coil insulation and in the reduction of fixed and stray losses of high speed machines.

Practically no new large generators were installed during the year, due of course to the fact that the central stations throughout the country had more generating capacity than load requirements demanded. Consequently, there was no increase in the size of gen-

s Marks Electrical Development

Intense timed impulses of light from the stroboscopic lamp make the revolving commutator appear stationary. (Photo, courtesy Westinghouse.)

erators — the 200,000-kv-a., 1800 r.p.m. units at Hudson Avenue Station installed in 1931 and 1932 still being the world's largest single shaft machines. Tests made on these machines indicate results better than the guarantees. A 183,333-kv-a. machine is being built for the Philadelphia Electric Co. This is an 1800 r.p.m. single element unit with two stator windings and cooled by external propeller type blowers. For the Port Washington Station, now under construction, an 80,000-kw. generator has been ordered and this unit will operate at 22,000 v. The initial generating unit at the Buzzard Point Station is a 35,000-kw. machine operating at 13,800 v.

As the size of generators has increased, the trend is towards the use of higher generating voltages. In this country 22,000 v. is the highest that has been used, but in Europe 33,000 v. machines have been used successfully for several years. In Europe also, they are leading in the development of large high speed generators. Recently an 80,000-kv.a., 3000 r.p.m. generator was built and supplied to Interescant in Belgium. The rotor of this unit weighs 42 tons, and when operating at rated speed has a peripheral speed of 346 miles per hour! A 60-kv.a., 1.0 power factor, 4800-cycle, 3-phase generator made recently represents an advance in the use of high frequency for industrial heating. Two single phase units of this kind were built.

Although the maximum capacity of water wheel driven generators has not increased during the year, the new generators which are to be installed at Boulder Dam will be the largest in the world, both physically and electrically. Construction of these machines is just being started, the first unit being scheduled for installation early in 1935 and the other later that year. The generators are rated 82,500 kv.a. unity power factor and are designed for 50 cycle generation at 150 r.p.m. and 13,800 v. or 60 cycle at 180 r.p.m. and 10,500 v. They will be smaller in diameter but both higher and heavier than the 77,500-kv.a. machines for the U S S R.

Developments in the field of synchronous motors cover a wide range and include both developments in the design of the machines themselves but also in their control. For certain purposes, motors of this type have been made with very high efficiencies—in one instance for municipal pumping service an 800-hp. 900 r.p.m. motor had a guaranteed efficiency of 97.6 per cent. Multispeed units have resulted in new applications being made, and at the Hawaiian Electric Co. it is believed the first synchronous motors driving forced and induced draft fans were installed. Part winding starting is increasing on motors where starting requirements are extremely heavy. The part winding steps in the case of one motor of this kind for flour mill service are arranged to provide starting torque in increments of 60 per cent normal torque to 175 per cent normal torque.

The thyratron tube has provided a new means of synchronous motor control. An installation of this kind was demonstrated this year in the G.E. test laboratories at Schenectady. It consisted of a 400-hp. motor and 18 Thyratron tubes. Power fed into the bank of tubes directly from a 4000-v. line is converted into different frequencies before it is delivered to the motor. This adjustable frequency of current results in adjustable speeds of the motor. The tubes in changing the frequency, perform the function of a commutator.

An interesting experimental synchronous motor was made recently by two engineering students.[2] This small motor, consisted of a simple stator with 2 poles and an armature made out of a single piece of cold rolled steel. This little machine when supplied with current at 700

[2]Electric Journal, July, 1933, page 310.

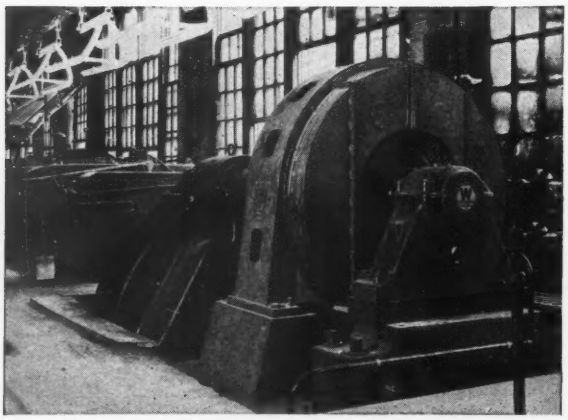


FIG. 2. 1000 HP. SYNCHRONOUS MOTOR FOR RUBBER MILL SERVICE WHICH CAN BE STOPPED IN 1¼ SEC. (PHOTO, COURTESY WESTINGHOUSE.)

cycles per second from a 500-cycle alternator speeded up, operated at the amazing speed of 42,000 r.p.m.! Seven hundred revolutions per second! Although the rotor weighed only half a pound, the force tending to throw it apart longitudinally was nearly three tons.

An extremely interesting large synchronous motor was built by Westinghouse for the Goodyear Tire and Rubber Co. for driving a rubber mill. This unit, a 1000-hp. machine, can be brought from a full speed of 512 r.p.m. to a dead stop in one and one quarter seconds, by means of dynamic braking.

Induction Motors and Other Motor Developments

Two important developments in induction motors, in the fractional horsepower, single phase class, were first the capacitor-start capacitor-run motor using a transformer and condenser and more recently the development of the capacitor-start induction-run motor employing a low voltage condenser of relatively large capacity for starting purposes only.

No doubt the most startling development in the motor field has been the application of the Thyratron tube in its control. One application of this type has already been mentioned, but it is not confined to synchronous motors alone. Each of the four principal types of electric motors, viz., d.c. commutator motor, squirrel-cage induction motor, wound-rotor induction motor and synchronous motor, may be used in conjunction with Thyratron tubes to produce a motor having new characteristics. The Thyratron commutator motor may be operated either on direct or alternating current. When operated on direct current this type of motor offers advantages of simplified construction and improved insulation over the conventional d.c. machine. When operated from an a.c. supply the motor shows great promise as an adjustable speed motor of great flexibility and high power factor. In addition to speed adjustment by the field as in the case of the conventional direct-current motor, the speed of the Thyratron commutator motor can be readily varied by changing the voltage of the alternating power supply. To change the supply voltage it is only necessary to use a tapped transformer, or an equivalent effect can be secured by changing the phase of the grid voltage of the Thyratrons.

From both manufacturer and user standpoint, an important development in the transformer field was the agreement upon a tentative test code for the impulse testing of transformers. This test procedure was presented in a paper by Messrs. Vogel and Montsinger at the A.I.E.E. winter convention in January. In the meantime the ranks of the manufacturers prepared to make commercial surge tests have been augmented by the installation by Allis-Chalmers of a high capacity surge generator capable of delivering a million volts.

Although the number of large transformers installed this year has been less than in previous years, the size of individual units is still increasing. At State Line Station a bank of three single phase power transformers, each rated at 33,333 kv-a., has recently been placed in service. In connection with this installation is also included a three-phase, phase-regulating transformer of 100,000 kv-a. output, designed for phase angle control. This unit as far as is known is the largest of its kind ever built.[3]

Tap changing methods have undergone a number of improvements during the year. A new type tap system[4] has been developed which is smaller and less expensive than former types and which makes internal arcs impossible. It also is applicable to small transformers and is capable of operation under short circuit. In another case, a quick operating tap changer has been developed for large distribution and small power transformers up to 15 kv.

More evidence was brought forth during the year to prove that the interconnection of the primary lightning arrester ground with the secondary neutral reduces trouble due to lightning without increasing the hazard to the customers wiring. A paper before the winter convention of the A.I.E.E. on Impulse Voltage Testing, by Harding and Sprague[5] emphasized this, and experience with this connection on 777 distribution transformers in 7 New England towns showed the advantages of the connection in New England. In Chicago,

[3]General Electric Review, September, 1933, page 398.
[4]Electrical World, March 25, 1933, page 396.
[5]Electrical Engineering, June, 1933, page 394.

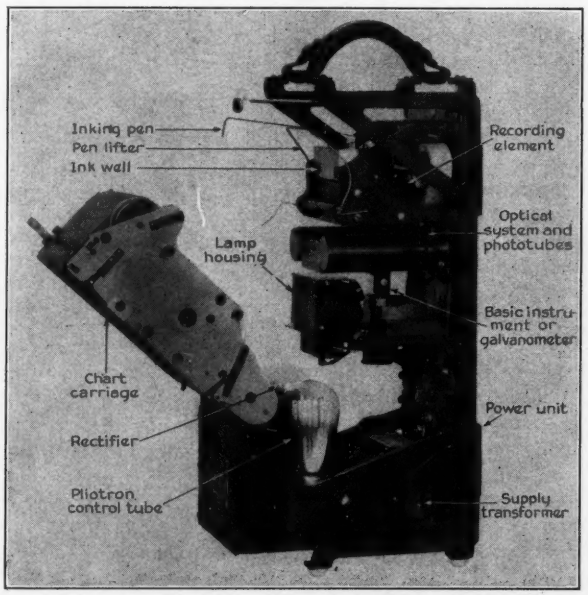


FIG. 3. NEW PHOTOELECTRIC RECORDING METER. (PHOTO, COURTESY GENERAL ELECTRIC.)

D. W. Roper[6] reported that this connection on 15 per cent of all distribution transformers reduced transformer failures by 40 per cent.

The use of Pyranol in transformers in place of oil has made possible the use of smaller secondary network units. Pyranol is a new, non-inflammable insulating and cooling medium. Being considerably more expensive than oil it was desirable as far as possible to reduce the amount of this liquid in the transformer. Careful study resulted in the design of single phase transformers with the volume of liquid reduced by as much as 35 per cent, thereby, lowering the cost differential between Pyranol filled and oil filled transformers to a value which in many cases is offset by savings in building vault construction.[7] Pyranol has also been used in capacitors to good advantage. Capacitors filled with this material are smaller in size and lower in price than those of similar capacity filled with oil.[8]

Circuit Interrupting Devices

The problem of circuit breaking continues to present a fruitful field for the application of new ideas and new principles. Since the development of the deionizing theory by Dr. Slepian a few years ago and the subsequent development of the Deion breaker, and the oil blast breaker, interest in circuit interrupting devices has been keen, and many refinements have been made on both of these. Since the oil blast breaker was introduced three years ago, material reductions in size have been made in almost every type of circuit breaker.

An interesting development recently was the production of a compression-type low voltage air circuit breaker. This is an extremely simple device making use of the high pressure developed by the arc in a closed chamber to extinguish the arc.[9] This breaker functions equally well on alternating or direct current.

Another new breaker developed this year was one of the oil blast type, which under test successfully withstood 10,000 operating cycles of opening and closing at 1200 amp. at 2300 v. without any maintenance.

For operating circuit-breaker solenoids from a.c. circuits use has been made of the disc type rectifier. This makes available the desirable qualities of the circuit direct-current solenoid to operate a circuit breaker without a battery and its attendant undesirable features.

Of considerable interest was the development of two new circuit breaker designs in the course of electrical engineering work at the University of Colorado.[10] One of these is an air-stream circuit breaker while the other is a steam-blast circuit breaker.

Transmission and Distribution

Although the field of electrical transmission and distribution was unmarked by any startling developments during the year, continued study and research in transmission line problems resulted in a number of improvements and refinements, all of which contribute to the advance of the art. Lightning, that chief enemy of electrical transmission, though still a formidable factor, is no longer the hopeless force it once was. Year by year by research and investigations, engineers have succeeded in mitigating the damaging effects of lightning and as reported this year, on one system of 374

[6]Power Plant Engineering, March, 1933, page 150.
[7]Electrical World, June 3, 1933, page 727.
[8]Power Plant Engineering, January, 1933, page 54.
[9]General Electric Review, July, 1933, page 315.
[10]Electrical Engineering, April, 1933, page 247.

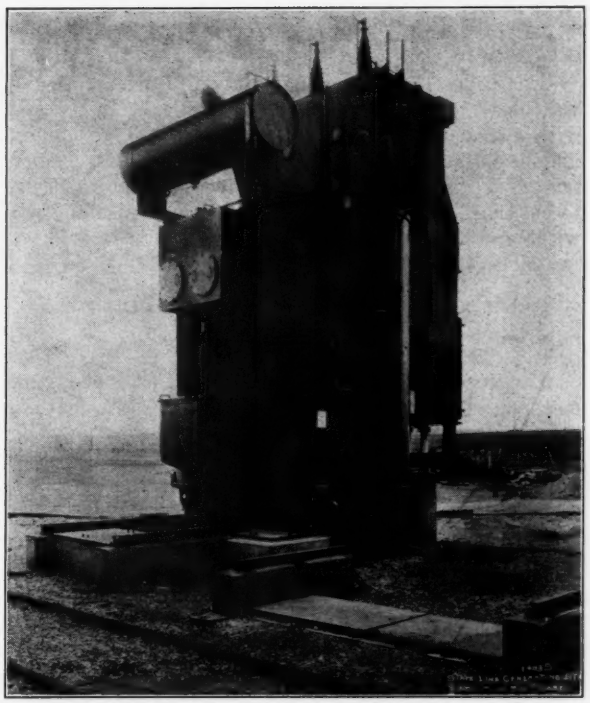


FIG. 4. 100,000 KV.A REGULATING TRANSFORMER AT STATE LINE. (PHOTO COURTESY GENERAL ELECTRIC.)

circuit miles of 132-kv. line, operation was maintained for 1½ yr. without a single flashover, though during that time the system was subjected to 110 lightning storms[11]. The use of wood for poles continues to show advantages in transmission line construction and many companies are experimenting with it. At the winter meeting of the A.I.E.E., H. L. Melvin presented operating experiences on the use of wood for transmission line work as obtained by the Electric Bond & Share Co.[12]

Of especial interest in the prevention of flashover is the recent development of the Deion flashover protector and the Expulsion Protective gap. These devices are designed for use on each transmission line tower. In case of a lightning discharge the device permits the discharge to pass through the device while the resulting power arc is extinguished without causing a system disturbance.

Technique in operation and maintenance continues to improve. This year a notable feat in high voltage technique was the raising of a 110-kw. circuit 6 ft. while fully energized. It has been found that the ground clearance on this line was insufficient to guarantee safety when hay derricks passed under the line. So an additional clearance of 6 ft. was provided while the line was energized by extending the tops and attaching the conductors to higher crossarms.

At the Century of Progress in Chicago, an interesting electric distribution was installed.[13] In order to keep the costs low, conventional methods of cable laying were abandoned and all equipment and construction was kept as simple as possible. Wood conduit was used for all underground cables. Specifications for feeder conductors called for a layer of paper tape around the copper,

[11]Electrical World, April 29, 1933, page 557.
[12]Electrical Engineering, January, 1933, page 36.
[13]Power Plant Engineering, July, 1933, page 393.

to separate it from the rubber insulation which made it easy to remove, thus saving labor in making splices.

For use on low voltage networks a new type of cable was announced this year.[14] This cable, it is claimed, will burn clear without producing any smoke, inflammable, explosive, or toxic gases during faults. Dielectric strength is high and is recovered after exposure to water. The new insulation cannot carbonize and will withstand high temperatures.

Developments in Electrical Instruments and Control

Progress in the development of new instruments and methods of control and measurement is so rapid these days that one has difficulty in keeping abreast of them. One reason for this rapid development is the increased application of the thermionic tube in this field. It seems that regardless of what type of measuring instrument is involved or what the commodity to be measured is, the application of the vacuum tube can effect improvements.

An excellent example of this is the photoelectric recorder, a new design of which was introduced this year. Recording instruments have been in use for many years, some of them remarkably sensitive and accurate, but never quite as sensitive or accurate as indicating instruments for the same purpose. With the application of the photoelectric tube and vacuum tube amplifiers, to the recording type of instrument, the sensitivity of the latter type of instrument has been increased so that it is the same as for the indicating type of instrument. A photoelectric recorder of this kind was developed about two years ago but this year many improvements and refinements have been made. So responsive is this instrument that communication circuits have been analyzed with it, noise and vibration measured. An interesting and very useful application of the instrument has been made in the recording of generator governor performance. When the photoelectric recorder is used for such a purpose, a separate pen is employed so that the governor response can be recorded on a high-speed chart immediately alongside the frequency record of the generator, this showing directly the true performance of the governing mechanism.[15]

Aside from the development resulting from the use of vacuum tubes, there has been considerable development in electrical instruments generally. There is a tendency toward reduction in size and shape of switchboard and portable instruments so as to afford a better utilization of space. A much needed refinement this year was the development of a new type of rectangular switchboard instrument having a parallaxless pointer. The monument-type pointer, shaped like half a lead pencil, is flush with the scale.

A new moving vane synchroscope with a burden of about four amperes per circuit is another development of interest.[16] This is only about one-fourth the energy consumption of previous types and makes it especially desirable for synchronizing power circuits when only potentials from condenser bushing devices are available.

A new type of ammeter having jaws that clamp around a conductor was a development this year that should prove useful. This ammeter is for use on either alternating or direct current circuits. On direct current circuits readings can be made if the cable is armored on in steel conduit.

Among the more complex instruments used in electrical measurements, is the recent development of a new portable multi-purpose oscillograph. It has the following features: 1 Simultaneous viewing of image and photographing. 2 An optical system that gives a brilliant trace that can be observed in a brightly lighted room. 3 A simple method of taking photographs similar to an ordinary camera. Aside from its use in electrical engineering it can be used for accoustical studies, for the measurement of vibrations, accelerations, pressures, etc.[17]

For use either in research or routine testing, the development of a new super-sensitive amplifier this year extends the range of current measurement to a new degree of smallness. This amplifier, in combination with a commercial type galvanometer makes possible the measurement of currents as small as 10^{-15} amp. and when used with a suitable sensitive galvanometer this range may be extended to 10^{-17}—0.000,000,000,000,-000,01 amp.![18]

PROGRESS in the development of new instruments and control equipment is extremely rapid these days due to the increased application of thermionic devices. Today for instance the D'Arsonval type of electric measuring instrument is available for use on A.C. circuits because of the application of disc type rectifiers. So too, the range of the D'Arsonval galvanometer has been infinitely extended by the vacuum tube amplifier. A new photoelectric recorder developed this year is so sensitive that it will analyze communication circuits. An amplifier was developed which will respond to currents as small as 10^{-17} amperes! With the ignitron control principle developed by Dr. Slepian, an arc is initiated in a few millionths of a second.

A useful device, brought out during the year was a "circuit analyzer".[19] This is a small but complete metering set, in reality a miniature three phase switchboard panel with all necessary instruments, transformers, resistors, switches, and terminals permanently wired. It is only necessary to connect for three phase testing a total of six wires, three from the line and three from the load, to enable an operator to make quick observation of current voltage, power and power factor.

[14] Electrical Engineering, October, 1933, page 682.
[15] General Electric Review, June, 1933, page 271. See also Electric Journal, March, 1933, page 108.
[16] Electric Journal, April, 1933, page 167.
[17] Electrical World, July 1, 1933, page 16.
[18] G. E. Review, March, 1933, page 156.
[19] Electric Journal, Sept., 1933, page 376.

As in the case of instruments there have been many developments in methods and devices for electrical control. One of the most interesting developments in this field this year was the announcement by Dr. Slepian of his "Ignitron" control.[20] This involves a new method of starting an arc and has application in connection with gas filled tubes, such as the mercury vapor tubes. It consists simply of a high resistance rod, lead or carborundum, partly immersed in the mercury pool (though later experiments showed that the mercury was not necessary) across which a potential is impressed. Upon attaining a certain minimum value, this potential initiates the main arc in the space of a few micro-seconds.

Another method of control for gas filled tubes which though it was not new this year but which had a number of new applications, is the condenser discharge method. In this as described in a paper in Electrical Engineering for March, 1933, the drop across a resistor through which a condenser discharge is passed is applied to the grid of the gas filled tube. This principle has been used in the operation of an electronic voltage regulator and also in a thermionic automatic synchronizer for use in central station practice.

New Supervisory Control

A new direct selection supervisory control system announced this year has a number of advantageous features. This system is based upon the fundamental method of relay valve operation in which current through the relay in one direction operates it, and current is blocked from the relay in the other direction. This system differs from the ordinary supervisory systems in that the apparatus to be operated at a remote point is selected directly without any intermediate connection to apparatus not to be operated. As many as 50 circuit breakers can be controlled over 4 lines while 25 can be operated over 2 lines.[21]

Many new developments in control equipment involve the photoelectric cell and during the year many new applications in this field have been made. For use in industrial processes requiring accurate control of the concentration of solutions, two regulator schemes for automatically controlling such concentrations were made available this year.[22] One of these uses a "balanced bridge" arrangement and utilizes two photocells simultaneously to inspect the light transmitted through a sample of the unknown liquor and through a standard calorimetric sample representing the desired quantity of the variable chemical. The second or nil method uses a single photoelectric tube inspecting simultaneously the light transmitted by the known and unknown sample.

In another application made this year the photoelectric cell is used to measure the hardness of water in connection with Zeolite treating systems. In this case light is merely passed through a sample of the treated water.[23]

Other Developments

These developments discussed in this article are among the most important made in the field of particular interest in the power industry, but it is by no means a complete list of all the electrical developments during the year. Little has been said here regarding research developments or developments in allied fields. In the X-ray field, this year saw the installation of an 800,000-v. X-ray tube at the Mercy Hospital in Chicago. At Massachusetts Institute of Technology, a ten-million volt electrostatic generator[24] was completed, which is to be used in researches in the structure of matter. In this field the year witnessed startling developments. In California, Professor Lawrence developed equipment for producing 25 million electron volts and with which he disintegrated lithium.[25]

Another discovery of the year was that of the heavy isotope of helium. Prof. Robert Millikan presented new proof of the selective distribution of cosmic ray energy values.

From this brief review it will be evident that progress in the technical field this year has not been slow and that regardless of business conditions, technical development goes on.

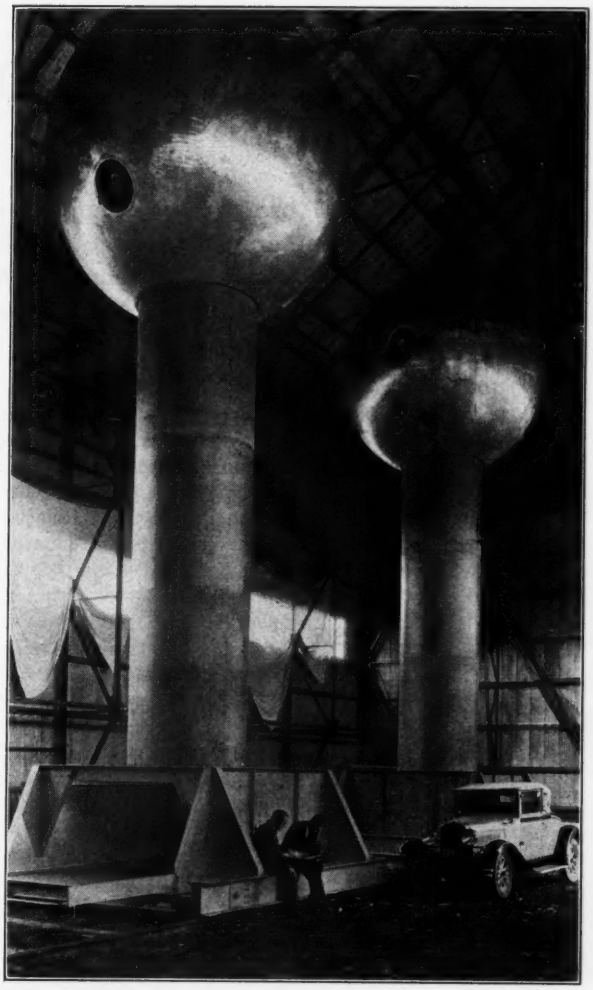


FIG. 5. TEN MILLION VOLT DIRECT CURRENT GENERATOR AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

[20] Power Plant Engineering, May, 1933, page 219.
[21] Electrical Engineering, February, 1933, page 81.
[22] Electrical Engineering, Sept., 1933, page 601.
[23] Power Plant Engineering, Sept., 1933, page 404.
[24] Power Plant Engineering, May, 1933, page 216.
[25] Chicago Entertains Engineers and Scientists. Power Plant Engineering, August, 1933, page 330.

A. S. M. E. Papers at N. Y. M

Abstracts of a number of the technical papers to be presented at the Annual meeting of the American Society of Mechanical Engineers to be held in New York, December 4-8.

PROBABLY at no previous meeting has such a complete and diversified program been offered to the engineer interested in combining business and pleasure on an interesting convention trip. The power engineer has been extremely fortunate, the papers presented being practical and dealing with timely topics as indicated by the abstracts of a few papers from three of the major divisions which are presented below.

Industrial Power

Steam and Power Supply

By Vern E. Alden, Stone & Webster Eng. Corp.

Need for a new industrial steam or power supply project may develop from: Construction of a new manufacturing plant; expansion or modification of processes in an existing manufacturing plant; desire for lower overall costs of steam and power; deterioration of existing equipment such as boilers; fact that space occupied by existing steam and power producing facilities is needed for expansion of the manufacturing plant.

Plans for such projects assume major importance in some industrial plants, where the total cost of steam and power is in the vicinity of 20 per cent of the overall manufacturing cost and also in large manufacturing plants where the yearly costs of steam and power may be only 2 or 3 per cent of the overall manufacturing cost but still are of such total magnitude as to justify the emphatic question, "Can they be reduced?"

While some of the many interesting technical aspects of planning industrial steam and power supply projects are referred to, the main purpose of the paper is to discuss some of the broader problems which industrial engineers and executives must face when making decisions involving the investment of considerable amounts of money in steam and power producing facilities.

Many of the most important potential savings relate themselves primarily not to the generation but to the use of steam and power, and before laying down any plan for an industrial steam and power supply project, the required duty must be closely estimated.

Industrial and Public-Utility Cooperation

By H. D. Harkins, E. I. du Pont de Nemours & Co.

Capacity of electric generators installed in industrial plants is at least 28 per cent of that installed in public-utility stations and the by-product electric energy which may be generated from present industrial steam flow is of such magnitude and may be generated so cheaply that industrial steam flow may well be considered America's most important potential source of additional electrical energy.

Modern technical developments in higher steam pressures and mercury-vapor cycles make available more and more surplus electrical energy from industrial steam flow, and this technical development favors the generation of electricity in connection with industrial processes. Industrial management must, however, be educated in the apparent paradox that small-scale back pressure power generation is more efficient than the quantity production in condensing central stations and a spirit of cooperation must be fostered by public-utility executives and engineers if industrial engineering antagonism is to be avoided and public relations improved.

Engineering in the Brewing Industry

By Victor Buhr, Equity Construction Co.

Power services are very important in brewery operation. About ¼ t. of refrigeration is required for every 31-gal. bbl., together with electrical consumption of 1500 watts and 800 lb. of steam. Other power services include water treatment, air conditioning (principally a future requirement), installation of measuring and controlling instruments, and the proper balancing of the steam load, perhaps through the use of accumulators. In all of these things, the mechanical engineer can make himself useful to the brewer. Another of his functions will be the determining of the most economical source for electrical power. He will be called upon to devise heat-recovery systems and to eliminate waste at numerous points in the plant.

It should be emphasized that the mechanical engineer will not be called upon to revolutionize the brewing business. The brewmaster remains supreme in his control of the processes, but there is no reason why the services of a mechanical engineer should not be extremely useful to him and no reason why mechanical engineers should not play a prominent part in the reconstruction and development of the brewing industry that are today in progress.

Power Equipment Investigations

Performance of 1000 Deg. F. Turbine

By W. A. Carter, The Detroit Edison Co., and F. O. Ellenwood, Cornell University

This paper deals with the results of a large number of tests to determine the thermal performance of a medium-sized turbine-generator designed for steam at a

Y. Meeting Reflect Technical Progress in Engineering

temperature higher than that ever before used in a turbine of this size. High-temperature steam at entrance to a turbine has the following advantages over low-temperature steam of the same pressure, used without reheating: (a) More energy is available for transformation into work for any specified exhaust pressure; (b) a larger portion of this available energy can be utilized; and (c) less erosion of the blades in the low-pressure stages is produced. Consequently, the temperature of the steam used by large turbines has risen rapidly in the last few years.

THE ANNUAL Meeting of the American Society of Mechanical Engineers is always the outstanding event of the year in the mechanical engineering field. This year, as in other years, this meeting will be characterized by an unusually interesting and complete series of technical papers covering a score or more separate divisions. While there will be sessions on problems of national recovery under the Management Division, the high point of the technical program are the symposiums on heat transmission, fuels, water measurement, industrial power, lubrication research, oil and gas power, central station practice, air conditioning and boiler feed water investigation. A number of the more important of these papers have been abstracted here, particularly those of interest to the power plant industry.

The turbine-generator tested is a 10,000-kw. unit operating at a speed of 3600 r.p.m., and using steam of 390 lb. per sq. in. abs at the throttle. Three regenerative feedwater heaters form part of the complete unit.

Analysis of the tests supports among others the following conclusions:

(a) The energy consumption of the complete unit (turbine-generator and three heaters) was 10,730 B.t.u. per kw-hr., for a load of 10,000 kw., a throttle pressure of 390 lb. per sq. in. abs, a throttle temperature of 1000 deg. F., and an exhaust pressure of 1 in. Hg. abs; this means a thermal efficiency of 31.8 per cent, and an engine efficiency of 76 per cent for the complete unit.

(b) A load of 10,000 kw. with 1000-deg. steam was not large enough to give the highest thermal efficiency of this unit.

(c) Increasing the steam temperature from 700 to 1000 deg. F. reduced the energy consumption of this unit 920 B.t.u. per kw-hr., or 7.9 per cent.

(d) The radiation and convection losses from the turbine and heaters with 1000-deg. steam were relatively small—namely, 0.6 per cent of the available energy.

(e) The loss due to the leakage of sealing steam was relatively large—namely, 4.4 per cent of the available energy for full-load conditions; this is probably not an inherent characteristic of large turbines designed for 1000-deg. steam.

High-Temperature Steam Experience at Detroit

By P. W. Thompson and R. M. VanDuzer, Jr., The Detroit Edison Co.

Experience gained from operation of equipment using steam as high as 1100 deg. F. leads the authors to believe that the design and construction of steam-generating plants using 1000 deg. F. steam is entirely feasible. This statement is based on information gained from two installations: one, a superheater located at Trenton Channel which has been in operation 23,000 hr., 21,169 of which were at 1000 to 1100 deg. F.; and the other, a superheater and turbo-generator located at Delray Power House 3 which has been in service 11,231 hr., 7832 of which were at 1000 deg. F. The Trenton Channel equipment, consisting of a small separately fired superheater and piping system designed to handle 6000 lb. of steam per hour at 400 lb. per sq. in., was placed in operation in 1929 to provide design information for the 10,000-kw. turbo-generator, piping system, and superheater later placed in service at Delray Power House No. 3 with 400 lb., 1000 deg. F. steam.

The austenitic 18 per cent chromium, 8 per cent nickel alloy was used for the construction of the Trenton Channel apparatus, with the exception of chrome-tungsten-vanadium flange bolts and low-carbon tubes used in the cooler portion of the superheater. Likewise, the 18-8 material was selected for the piping and for the hotter portions of Delray superheater, notwithstanding reports from abroad of serious failures received after the Trenton installation was placed in operation. Examination of tubing from Trenton Channel after 6408 hr. of service had shown no appreciable change in properties of the alloy.

Results of examinations made on various materials from both installation show that some changes have

taken place. Loss of strength or tendency toward embrittlement has not progressed to such an extent that consideration has been given to the replacement of any parts.

Turbine troubles have been the leaky throttle bonnet joint, wear of all the shaft packing caused by rubbing during start-up periods, and binding of the thottle valve stem. This latter difficulty was caused by the growth of a semi-steel packing sleeve. This bushing, as well as similar ones in the five control valves, has been replaced with nitralloy, which thus far has been satisfactory. Troubles experienced with loose tube tiles in the superheater have been eliminated by alterations to the setting.

Leaving Losses in Steam Turbines

By Ernest L. Robinson, General Electric Co.

An exposition is given of the various items which go to make up the leaving velocity and exhaust loss of a steam turbine. The importance of this loss and the rapidity with which it increases at high loads cause it to be a determining influence in fixing the economic rating of a machine. The several elements necessary for an analysis are each evaluated in a fairly direct, although sometimes approximate, manner.

IT IS doubtful that five years from now the executives of any stable industry or the utility serving the territory in which that industry is located, will view with equanimity the generation of as much as 200,000 lb. of steam per hour at low pressure and high load factor, and with a negligible amount or no generation of by-product power. ***From Vern Alden's paper, Some Broader Aspects of Planning for industrial power and steam.***

The loss in question occurs in the exhaust hood between the last wheel exit and the exhaust flange to the condenser. It is made up both of kinetic-energy loss and of pressure loss through the hood, and each effect varies both with load and with location around the wheel annulus. Moisture is allowed for; supersaturation is neglected.

Correct values of the loss may be expressed in terms of heat equivalent in B.t.u. per pound flow to the condenser, or as a per cent of the adiabatic heat drop, or as a per cent of the total theoretical energy available within the flowing steam between throttle inlet and the several extraction and exhaust flanges, for conversion to switchboard power. Thus it is correct to speak of a loss of 30 B.t.u. per lb. flow to the condenser. But such a statement is not very significant. If the adiabatic heat drop is 500 B.t.u. the loss may be said to be 6 per cent of the adiabatic heat drop. But there is still an uncertainty as to the effect on the power generated, since the 6 per cent loss applies only to the steam going all the way through the turbine. If five-sixths of the power generated comes from steam which goes all the way through the turbine, then the true loss is 5 per cent of the theoretically available power which, for the reasons discussed, fails to appear on the switchboard.

The type of service and conditions of operation are very important. Thus a base-load machine requires a more liberal exhaust than a machine designed for a broad range of service. This brings attention directly to the load curve as the important feature that operators consider in the selection of a turbine. Together with throttle loss at light loads, which dwindles out at full load, the leaving velocity and exhaust loss, which increases from very little at light loads, is one of the most effective tools the turbine designer uses in producing the type of machine suited to required conditions.

Proper Exhaust-Pipe Length

By Kyle C. Whitefield

When new exhaust pipe was being installed for the one-cylinder, 50-hp., two-stroke cycle Fairbanks-Morse Co. Diesel engine on which the tests for this thesis were performed, it was decided to make tests at various lengths of exhaust pipe. These tests showed such a widely varied range of engine performance that a more detailed investigation of the problem was made, and this paper contains the result of that investigation.

Judging from the full-load fuel rates obtained by these tests, the most favorable lengths of exhaust pipe are 38 ft., 64 ft., and 86 ft.

The engine speed for the test was 362 r.p.m., which gives 0.0004606 sec. per degree of crank travel. Therefor the velocity of the pressure wave equals Distance/Time = 1380 ft. per sec. The velocity can also be calculated between stations "before muffler" and "after muffler" and is found to be 1408 ft. per sec., or 2 per cent different from the first value. They should be the same, but reading and plotting inaccuracies caused the difference.

These two values of the velocity of the pressure wave in the exhaust pipe are practically the same as the velocity of sound in the exhaust gas at the engine-exhaust temperature.

Consider what takes place in the exhaust pipe for one revolution of a two-stroke cycle, single-cylinder, internal-combustion engine. When the exhaust port opens, a relatively high pressure impulse is started along the exhaust pipe which travels along the exhaust pipe at the velocity of sound. It goes out to the end of the pipe, and in some manner a reflection is propagated back down the pipe, where it is reflected from the closed exhaust port and so on until it is damped out. However, if it should return to the exhaust port as the port is opening or open, it will cause detrimental effects to the scavenging of the engine and make for poor operation.

Burning Characteristics of Pulverized Coals

By Ralph A. Sherman, Battelle Memorial Institute

Results are given of an experimental investigation the object of which was to determine the relation of the rate of burning of pulverized fuels and of the radiation from their flames to the type of coal and its fineness of pulverization.

Studies have been made of four coals: Ohio No. 6, Pocahontas No. 3, Illinois No: 6, and Pittsburgh No. 8. A normal rate of firing was about 200 lb. per hr. or about 2,700,000 B.t.u. per hr. Tests were also made as low as

1,375,000 and as high as 3,450,000 B.t.u. per hr. Finenesses of grinding of 40 to 95 per cent through 200-mesh were used. Some results of the combustion studies reported in the paper were:

1. The rate of decrease of unburned carbon with increase of excess air was not the same for different coals. The unburned carbon continued to decrease up to 30 per cent excess air with Pocahontas coal, where as there was little decrease beyond 20 per cent excess air with Hocking coal.

2. The fineness of grinding becomes increasingly important as the combustion space is restricted and the optimum limits of fineness, without regard for power consumption in these experiments, differed with the type of coal.

3. Although the Pocahontas coal, 18 per cent volatile content on moisture- and ash-free basis, was the slowest burning of the four coals, Illinois coal, volatile content 42 per cent, burned more slowly, and Pittsburgh coal, volatile content, 44 per cent, burned only slightly more rapidly than Hocking coal, the volatile content of which was 40 per cent.

Air Heaters and Economizers

By Henry Kreisinger, Combustion Engineering Corp.

In general, heat is transferred from the hot gases to the gas-swept surface of an air heater or an economizer by convection; through the metal wall of the air heater or economizer it is transferred by conduction; and from the air- or water-swept surface it is transferred into the mass of air or water by convection. When considered in detail, the part of the path of the heat transfer by conduction is somewhat more complicated. The metal surfaces on the gas side are usually covered by a layer of soot and ash. Adhering to this layer of soot and ash is a film of continually changing gas. On the air side of the metal wall of an air heater is a similar film of air. Heat is transferred from the hot gas by convection into the gas film; from the gas film it is transferred by conduction through the layer of soot and ash, and through metal wall into the air film; from the air film it is transferred by convection into the moving body of air.

The following simple equation is useful in determining the heat transfer in an air heater: $H = (R + BW)(T - t)S$, where H = the quantity of heat transferred per hour, A and B are constant determined from test results, W = average of weight of gas and air per square foot of cross-section area per hour, T = mean temperature of gases, t = mean temperature of air, S = effective heating surface in square feet. The average value of A is 0.4, and that of B is 0.00045.

In an economizer there may be a layer of scale on the water side of the metal wall, and next to this scale is a film of water. The heat travels by conduction through the metal wall and the layer of scale into the film of water from which it is taken into the stream of water by convection. The rate of heat transfer by convection in the gas and air stream in an air heater and the water in the economizer varies with the weight of gas and air or water passing over the surfaces. The temperature is low, and the range of temperature variation is small so that the effect of temperature on the rate of heat transfer is negligible. The rate of heat transfer by conduction varies directly with the conductivity of the material forming various layers, films and metal walls, and inversely as their thickness.

In an economizer the weight of water passing over the heating surfaces and the heat-absorbing capacity of the water is large so that the water takes up readily the heat transferred to the metal wall by the hot gases. The temperature of the heating surface is close to the temperature of water. Therefore, the heat transfer by convection from the gases to the metal determines the rate of heat transfer and the calculation of the performance is simplified. In the preceding general equation, W is the weight of gases per square foot of cross-section of the gas passage, T is the mean temperature of gases, and the mean temperature of water. The averages of constants A and B are 2.2 and 0.00095, respectively.

Heat Transfer

Mercury Systems

By W. T. Moore, Babcock & Wilcox Co.

Heat transfer in mercury systems involves primarily evaporation and condensation. The low specific heat of liquid mercury practically eliminates the use of this material in the liquid form. The superheated vapor also has a low specific heat, and its use is practically limited to overcoming pipe-line condensation.

Mercury boilers have been operated with heat inputs of 90,000 B.t.u. per hr. over a vertical tube having 3.5 to 4 sq. ft. heating surface located above a furnace having a temperature of 3000 deg. F. and with 925 deg. F. mercury vapor inside the tube. In ordinary practice the heat input is kept below this figure. Sufficient evidence is available to indicate quite definitely that, with proper design, calorized carbon-steel tubes are satisfactory up to vapor temperatures in the neighborhood of 900 deg. F., with a corresponding pressure of about 80 lb. per sq. in. gage. Carbon-steel tubes uncalorized may be used for vapor temperatures up to about 750 deg. F.

With regard to condensation, the vapor which touches the cold condensing surface is the vapor that is condensed, and the important point is to keep a fresh supply of vapor in contact with the surface and to remove the condensate from the surface as speedily as possible. At the beginning of a condensing process only vapor is present, the resistance to heat transfer from the cold surface to the vapor is practically zero, and a high rate of heat transfer results. As condensation proceeds, there is a tendency for a film of condensate to collect. For some liquids this film may be fairly thick and may interpose considerable resistance, but this is not the case with mercury, which does not wet the surface. Therefore, comparing mercury with other liquids, we would expect higher heat-transfer coefficients in condensation and lower in boiling.

Condenser Cleanliness-Factor Measurement

By P. H. Hardie and W. S. Cooper, Brooklyn Edison Co.

Determination of the cleanliness factor of a condenser consists in installing several new tubes in representative positions in the condenser just prior to the test, isolating the new tubes and certain adjacent old ones by means of rubber-hose jumpers, and determining the performance of these in terms of heat transmittance. The ratio of average heat transmittance of the old test tubes to that of the new at the same water

velocity and inlet temperature has been defined as the clealiness factor.

An investigation has been carried on to ascertain the probable accuracy of the clealiness-factor measurement when determined from 24 isolated sample tubes. The sufficiency of 18 old tubes and 6 new tubes for yielding a reliable value of the cleanliness factor was thought to be established adequately by increasing the sample size to 96 test tubes.

The accuracy of the cleanliness-factor measurement should not be confused with that for the overall condenser test, which includes the measurement of many other variables that are necessary to evaluate the performance. Furthermore, it is necessary to know the relation of the overall performance to cleanliness factor (other operating conditions remaining constant) in order that the performance under fouled conditions can be correctly appraised. The manufacturers in their guarantees for cleanliness factors less than unity have generally assumed that the overall heat transmittance is reduced by fouling in direct proportion to the cleanliness factor. The present test, together with two previous tests on the same unit at higher cleanliness factors, has shown that this relation is not strictly true. Sufficient test data are not available at present to establish any quantitative values for this relation.

Papers on Hydraulic Practice

Hydraulic engineers will be especially interested in the symposium of papers on Water Measurement to be presented at the sessions of the meeting held under the auspices of the Hydraulic Division. The question of water flow measurement is one which has become increasingly more important and more difficult as the sizes of hydroelectric generating units have increased. For this reason the subject has been of active interest to hydraulic engineers and in the last few years many investigations have been made to develop more accurate methods of measurement. Two sessions will be devoted to papers on this subject, one on Tuesday morning and the other Tuesday afternoon. Abstracts of the more important papers to be presented at these sessions are presented in the following paragraphs.

Analysis of the Gibson Method of Water Measurement

By Dr. D. Thoma, Prof. Technische Hochschule, Munich, Germany

This paper begins with a discussion of various methods of measuring water which were in use when the Gibson method was first announced.

Current meter measurements seem to be affected to some extent by the turbulent accessory motions which cause periodic velocity changes both in magnitude and in direction. The real problem is to determine accurately the average value of the velocity vertical to the measuring section. With Woltman's current meter, changes in magnitude are not serious, but changes in direction are disturbing. Of late current meters have been invented to overcome these difficulties, but they are subject to errors through collection of threadlike debris in the water. Another difficulty in determining discharge by current meters is the impossibility of determining the velocity close to the walls. Wall current meters are in the stage of development, however, and their use promises greater accuracy. Also the necessity of determining the velocity at a number of points in the cross-section at a given time, due to the temporary slow changes in distribution, makes the current meter method expensive. Under favorable conditions and with careful work, the accuracy of the total measurement made by current meters may be assumed to be about 1 per cent. Under favorable conditions, of course, larger errors are possible.

The Gibson method is applicable for measurements in closed conduits and is founded on the pressure rise which takes place in such conduits when the flow is brought to rest. For carrying out the test for a turbine plant, a steady continuous flow is maintained, and thereafter the turbine gates are gradually closed. The increased pressure in the conduit is continuously registered by a pressure-time recorder. From the pressure diagram the difference between the initial water flow and the leakage flow is obtained. The dimensions of the conduit must of course be known. It is easy to determine the small amount of leakage water with great accuracy by a special test, and it is therefore possible to determine the water flow at the open steady position of the gates.

Having proved the fundamental equation of the Gibson method Professor Thoma proceeds to discuss the possibility of four small errors in the application of the method. If the influence of friction and the accompanying accessory velocities are considered, then he shows that an error may be introduced which is of the order of about—1 per cent. This conclusion is arrived at by considering the influence of accessory velocities upon pitot-tube readings and by relating this influence to the conditions existing just prior to and during the taking of a pressure-time diagram. The error, due to accessory velocities, is called error No. 1.

The assumption that the friction during the closing of the gates is just as great as that at continuous steady flow with the same amount of water is possibly not strictly true. The downward friction force is carried over on the water from the pipe wall which touches the back flowing edge current. This condition decreases the value of friction below the amount which would be present at an equal water quantity at steady flow. Estimating the resulting error as 1/20 to 1/10 of the friction at continuous flow at the beginning of the measurement, Professor Thoma indicates that this error in the measurement would amount to about + 1 per cent. It should be remembered that these statements are predicated upon very rough estimates, and consequently only the possible order of magnitude of the errors should be considered. The error due to a false valuation of friction of the water conduit is called error No. 2.

In considering the error due to the fluid friction of the mercury column, the assumption is made that for the small motions employed, the friction is proportional to the first power of the velocity. With this assumption it is easy to show that the total impulse absorbed by friction is dependent only on the difference in the pressure at the beginning and at the end of the observation. Accordingly, this error, called error No. 3, is estimated to be of the order of about—0.5 per cent.

Due to the inertia of the mercury column, an error may be introduced tending to increase the water quantity. This error, called error No. 4, is therefore positive in sign at the beginning of the observation.

Photoflow Method of Water Measurement

By Dr. William Monroe White, and William J. Rheingans, Allis-Chalmers Mfg. Co.

This paper is written for the purpose of reestablishing in the minds of hydraulic engineers the pitot tube as a useful and accurate instrument for determining the flow of water by putting pitot-tube measurements upon a more exact basis. The photoflow method of water measurement as described by the authors is the photographic record of the differences in pressures of pitot-tube points positioned throughout the cross-section of flow, and piezometer connections positioned to indicate the pressure across the section of flow.

The paper deals with the actual volumetric calibration of the photoflow method under extremely disturbed and turbulent conditions of flow. A coefficient of 0.971 was established for these conditions, which represents about the lower limit of pitot-tube coefficient, no matter how turbulent the flow. The results of a large number of calibrations with a known velocity flowing and with properly constructed piezometers have in the past shown coefficients of pitot-tube measurements of about 0.976 as most generally applicable for normal flow conditions. The authors claim therefore that the adoption of 0.976 as the coefficient for use with the photoflow method will give an accuracy of one-half of 1 per cent because of the narrow range limit of the coefficient for different conditions of flow.

It is shown that the principal feature of the photoflow method, as distinguished from the pitot-tube traverse, is the simultaneous record obtained during a fraction of a second of all the readings of multiple pitot-tube points rigidly fixed throughout the measuring section, in addition to all the piezometer readings. Observations on the flow of water in conduits show that although the quantity flowing past any section may remain unchanged, the velocity at any one point in this section may vary widely. Since the continuity of flow must be maintained, a change in velocity at one point is accompanied by an equal and opposite change at some other point. Actual tests with the photoflow method showed that in turbulent flow the variation in velocity at one point may be as much as 30 to 40 per cent, without the least change in the quantity flowing past the measuring section.

CAPACITY of electric generators installed in industrial plants is at least 28 per cent of that installed in public-utility stations and the by-product electric energy which may be generated from present industrial steam flow is of such magnitude and may be generated so cheaply that industrial steam flow may well be considered America's most important potential source of additional electrical energy. ***From H. D. Harkins' paper, Industrial and Public Utility Cooperation.***

How Water Flows in a Pipe Line

By Charles M. Allen, Worcester Polytechnic Institute

During the last few years, a good many conjectures have been made as to how water actually flows in a pipe line. The assumptions have varied from streamline or parallel flow to the Clemens Herschel idea of watching the path of feathers from a pillow opened in a windy narrow street.

After many years of investigating and using the salt-velocity method of water measurement in pipe lines, we have come to the conclusion that there is no such thing as streamline flow above critical velocity and that Mr. Herschel's theory was a very good illustration of how water actually flows. Possibly a better illustration of the picture would be that of a bird's-eye view of a flock of sheep being driven along a country road, lined on both sides with good feed. The sheep in the middle will be trotting alone, gradually working their way to the side of the road, slowing down in so doing, grabbing a bite to eat and then walking more or less interfered with, finally getting back into the center, and perhaps the next time getting a bite on the other side of the road. The moving sheep present a slightly convex front, as they are traveling faster in the center of the road and almost coming to a stop on the side. A salt-velocity traverse curve compared to an instantaneous velocity curve of pipe-line flow makes this illustration seem reasonable.

For the last year or more, work has been carried on at the Alden Hydraulic Laboratory for the sole purpose of getting a mental picture as to just how water does flow in a pipe line. This was accomplished by continuously injecting brine through a small tube into a pipe line at a given point upstream from several individual electrodes spaced uniformly across the pipe. As the salt is in solution, where the salt goes the water must go.

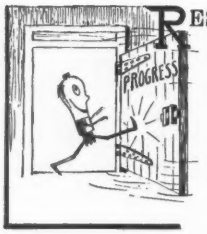
For these investigations, the lower end of the 40-in. steel riveted penstock supplying water to the main laboratory was used. At each station, two taps were made in the penstock so that two traverses for the injection of the brine could be made. These traverses were on diameters 90 deg. apart.

The electrodes were made of galvanized-iron screen 3 in. in diameter, of ¼ in. mesh, separated from each other ½ in. These individual pairs of electrodes were mounted on the ends of ⅜-in.-square insulating rods 6 in. upstream from the supporting frame. The 21 pairs of electrodes were wired separately to 21 ammeters of ½ amp. capacity arranged on a board in a position corresponding to the electrodes in the pipe. The voltage supplied to the circuits was 110 a.c. The salt was introduced through a pitot tube facing downstream. This tube could be held at any position across the diameter of the pipe.

The conclusions are: (1) The dispersion of the salt solution is surprisingly large, especially in the shorter sections. (2) The amount of dispersion is comparatively constant for all positions in the traverses except those close to the wall. (3) The amount of dispersion is comparatively constant for the range of velocities used. (4) No apparent effect on dispersion due to difference in specific gravity of the salt solution and water is shown by the diagrams. (5) Assumptions of streamline or parallel flow apparently should not be made for ordinary penstock conditions.

RESEARCH Opens the Door t

Ideas Taken from the Laboratory and Developed in the Experimental Plant Have Contributed Greatly to Economy, Safety and Improved Commercial Operation.



RESEARCH, in popular parlance, runs the gamut from so-called pure science, as in connection with atomic structure investigation, to cut-and-dry engineering which would no doubt be highly flattered by the more simple term experimentation. Taken as a whole a tremendous amount of investigation is being done and a large percentage of the 1575 listed[1] industrial and commercial laboratories have one or more active projects of interest to the power plant field. In addition to this, a great deal of work is being carried on by individuals, manufacturers and private companies outside of laboratories.

In fact it might be well to subdivide the field, as has been done to a certain extent by popular usage, into two divisions, pure science and industrial research. The first to deal with the fundamentals of structure, action or reaction, the second with the application of these fundamentals to engineering problems. The second might well be further divided into application and experimentation, application dealing with the principle of scientific principle, experimentation with the practical engineering problem of physical design and control of the actual machine. More accurate definition of these fields might well be subject matter for another research (or standardization) project.

Steam Table Research

With such an array of material and such a broad field, it is possible to review only the more fundamental of the projects, selecting those which bear directly on the field of power generation and application. Of these probably the steam and water properties research being carried out jointly by the Bureau of Standards, Massachusetts Institute of Technology and Harvard University is the most fundamental and the only one that might be included in the pure science field.

This work organized through the A.S.M.E. has been going on since 1921. From the Harvard data, assembled first, Keenan prepared the A.S.M.E. steam tables in 1930. In 1932 a new calorimeter[2] for high pressures was completed at the Bureau of Standards and during the past year enthalpy of saturated liquid and vapor was extended up to and exceeding 2500 lb. pressure, virtually completing this phase of the work. At M.I.T. investigation of the liquid phase above the liquid line and the superheated vapor phase above the saturation line has been completed and the region above the steam dome virtually completed by means of a new Nirosta steel container made in 1932. Data from these investigations are in agreement with each other[3] and in general with European investigations. Correlation of all these data with the International Steam Table[4] will undoubtedly make it possible to reduce the tolerance limits at many points. This table is made in skeleton form using reasonable values but with varying tolerances to include the values of all recognized investigators.

Metals at High Temperatures

Value of accurate steam tables in the higher temperature and pressure ranges cannot be over-estimated. This field is rapidly being explored. The most promising work during the past year being the operation of the 10,000-kw., 1000 deg. F. Delray turbine. This experiment is the culmination of several years' experimental research work on effects of high pressure steam on metals and methods of superheating. Early research disclosed that steam does not dissociate appreciably at 1100 deg. F. and that this steam could be controlled. This latter problem ran into extensive investigations of alloy piping, welding, valves, flanges and joints.[5] The turbine has now been operating 11,231 hr., 7832 of which have been at 1000 deg. F. temperature. At 1000 deg. F. the heat consumption[6] is about the same as the 50,000-kw. units and at 700 deg. F. it is about 8 per cent higher. Because of the greater cost of oil for the separately fired superheater, the 1000 deg. F. unit is not as economical even though there is no appreciable difference in heat economy.

In this as in all high pressure and high temperature installations, welding plays an important part. Welding research has been so successful that welded boiler drums this year became standard practice and are now quite common. They have done much to reduce constructional and operating difficulties with boiler drums. The most important developments in this connection during the past year, however, was the acceptance of welded lines for higher pressures. Burlington Station was a noteworthy installation of all welded piping[5] in the central station field and the Bogaluse Paper Co. in the industrial field. This latter installation was the first to use flangeless valves welded in the line. Probably the most outstanding result of welding research was the steam distribution system at Schenectady of almost 2 mi. of welded line,[7] a view of which is shown on page 511.

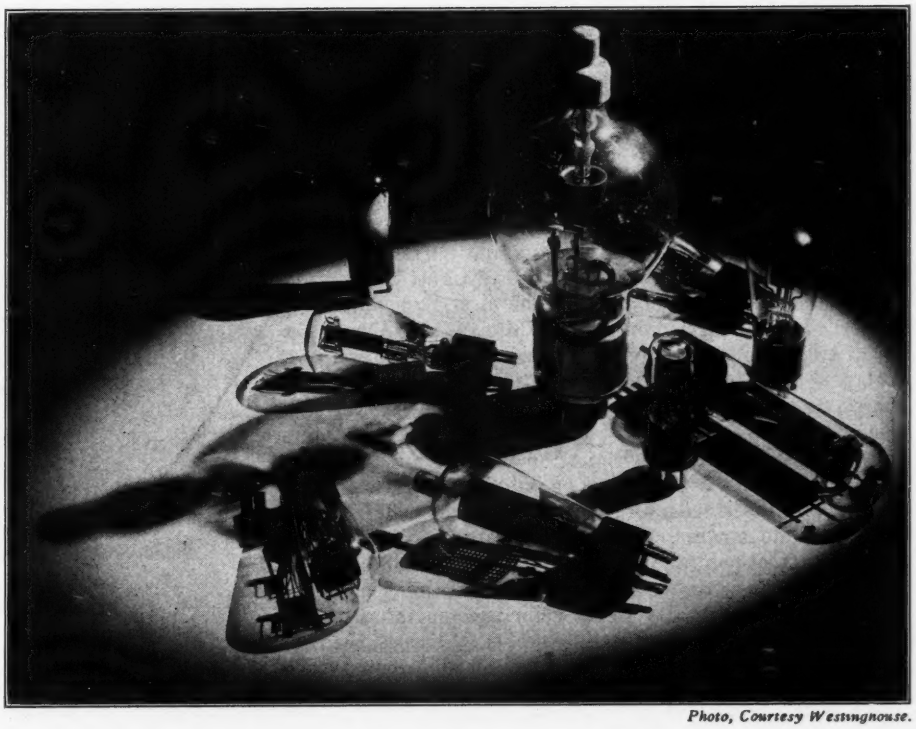
Constant research is improving welding methods and

[1]Bulletin 91 National Research Council, The National Academy of Sciences, Washington, D. C. (1933)
[2]Steam Research, Mechanical Engineering, February and March, 1933.
[3]Steam Table Research, A.S.M.E. December Meeting, 1933.
[4]Power Plant Engineering, Jan. 1, 1930, p. 83.
[5]Edison Electric Institute Publication No. A 2, August, 1933.
[6]Performance of 1000 deg. F. Turbine, Ellenwood and Caster, A.S.M.E. December, 1933, meeting.

or to *PROGRESS*

TOOLS OF MODERN RESEARCH

Tubes that feel, tubes that see, tubes that amplify and do a hundred other things.



Photo, Courtesy Westinghouse.

technique, one important development being an improved method of oxyacetylene welding heavy wall pipe. Increasing use of large brass pipe resulted in research on joint design which disclosed that the simple vee type joint welded with bronze rods gives an entirely satisfactory connection of high efficiency. Welding costs are practically the same as for welding steel pipe with steel rods and position welds can be accomplished with the same facility. Building up worn parts such as piston rods by welding and then turning to size has been practical for some time. Recently this building up process has been successfully accomplished by spraying molten metal,[8] a development which offers considerable promise.

Welding Inspection

Just how far welding will be carried in the construction and erection of machinery is difficult to say, but many manufacturers are making extensive use of it for frame and bedplate construction and even for condenser shells, the 60,000-sq. ft. Kearny condenser being the latest unit of this kind. Mention has been made before of the use of welded drums. One of the big advantages of welded drums was said to be the absence of cracks to foster caustic embrittlement, at least as far as the drum was concerned.

Welding of pressure vessels resulted in a great deal of research in X-rays in order to meet the inspection provision of the boiler code. This has been improved and extended until it is now possible to inspect 5 in. thicknesses by using 300-kv. tubes. This could undoubtedly be extended by using higher voltages (800-kv. tube is in use in a Chicago hospital[9]), although research the past year[10] has made effective use of gamma rays for thicknesses up to 8 in.

Feedwater Research

Use of welded drums does not of course eliminate embrittlement around and in tubes, especially if they are not properly rolled. Embrittlement in itself is fairly well under control, however, due largely to the masterful work of, first, Parr and then Straub[11], at the University of Illinois. Recommended alkalinity ratios are sometimes difficult to maintain, however, and there has been some criticism which has resulted in a program of research to be undertaken by the Bureau of Mines and sponsored by the A.S.M.E.[12]

Another research project at the same university deals with the removal of sulphur compounds from flue gases.[13] This work carried on by Johnstone, has made splendid progress in the removal of sulphur by catalytic oxidation methods. This subject is related to the coal washing and cleaning studies being carried out by the Bureau of Mines and also to the studies being made to determine the effect of heat air on combustion of coke and coal. This work, under the direc-

[7]Transporting steam at 400 lb., 750 deg. F. By R. H. Rogers, Power Plant Engineering, October, 1933, p. 422.
[8]Journal of American Welding Society, Sept., 1932.

[9]General Electric Review, p. 138, April, 1933, p. 206, March 1933.
[10]N.E.L.A. Publication No. 241, January, 1933, p. 27.
[11]Embrittlement in Steam Boilers, F. G. Straub, Power Plant Engineering, p. 444, October, 1933.
[12]Progress Report from the Research Study at the Bureau of Mines, by J. H. Walker, A.S.M.E. December, 1933, meeting.
[13]Reprint No. 2, Engineering Experiment Station, University of Illinois, Urbana, Ill.

tion of Nicholls, has already shown the value of preheat in increasing combustion rates and when finished will be of the utmost importance in interpreting the action and operation of underfeed stokers. Closely related is the research work on radiation from flames at M.I.T. and on pulverized fuel investigations[14] by Sherman at Battelle Memorial Institute.

Foaming and Priming

Another phase of the A.S.M.E. Research program (carried on jointly with a number of other engineering societies) is the sponsoring of an investigation on priming and foaming of boiler waters. This work is being carried on by Foulk at Ohio State University and has already produced some interesting results. The interrelation of soluble and insoluble salts and particles on the stability of surface films is being investigated.

Perhaps the research program of most immediate interest was that carried on under White at the University of Michigan. These investigations on water analysis deal primarily with the determination of carbonate, phosphate and hydroxide in boiler waters and are available in a 29 pp. paper bound book recently published by the A.S.M.E. A further report on the determination of sulphate in boiler water will be published if interest warrants it. Standardization of test and analysis methods should do much to clarify the entire question of feedwater treatment and control. By settling points of difference such as discussed by Hecht, McKinney and Straub on chemical analysis in embrittlement studies in the June 1, June 15 and December 1, 1931, issues, the fundamental problems can be attacked on all fronts at once by investigators using the same methods of attack.

Flameproof Lubricants

Turbines have not been neglected and research, particularly on blade metals,[15] has definitely reduced outage from this source. More spectacular perhaps is the research on flameproof lubricants spurred on by four disastrous oil fires[15] resulting from oil ignited by hot steam lines. Various phenol compounds are under test by many central station companies and manufacturers which will undoubtedly yield definite results before the end of next year.

In fact this line of investigation has already proved productive in the electrical field, a new flameproof insulating fluid being responsible for a material reduction in the size of transformers and capacitors described in a previous article. Research in the electrical field is, as a rule, more spectacular than in the mechanical due, perhaps, to the remarkable adaptability of electricity, its potentialities and the still unsolved mysteries by which electrical phenomena forms the basis of our material world.

Electrical

Under such men as Millikan, Aston, Lawrence, Van De Graff[16] and others the impregnable atom is slowly breaking down and the age old dream of the alchemist —transmutation of metals—is already in sight. Lithium has already been broken up into helium and hydrogen and other elements are undergoing experiment with every indication of early success. During the past year many new isotopes have been discovered, few of the elements retaining their single standard. Even hydrogen, the former model of consistency, at an atomic weight of 1.008, was embarrassed when black sheep, isotopes with an atomic weight of 2, were dis-

COBALT STEEL FLOATING IN AIR
A development of the Westinghouse research laboratories.

covered in the family. This isotope is being used to advantage in atomic disintegration, and the nucleus has been named the deutron. Because of its weight the deutron, accelerated to high speeds, possesses great energy and makes an excellent projectile in disintegration experiments.

Closely allied is the work on electronic tubes. These devices are remarkably flexible and are already in wide use[17] as mentioned in other articles in this issue. Apparently the field has just been scratched, however, and more intensive research will open up avenues as yet undreamed of. Industrial control, time delay devices, voltage regulators, process control and motor control are but a few of the possible applications.

Distribution of the vast quantity of electricity already used involves cable and insulation problems which have been the subject of a constant research.[18] Recent insulation investigations may be divided roughly into oil investigations, capillary action of oil on paper, and the properties of paper itself. In addition to the regular work on copper and aluminum conductors, research was conducted on pipes filled with solid sodium primarily for use on low voltage permanent installations as in the electrochemical industry. Tests on a 4-in. standard pipe filled with sodium was built to carry 4000 amp., about the same capacity as four 1,000,000 circular mil copper circuits. The conclusion after a year's service was that its performance and cost was comparable with copper. Other electrical research developments are discussed in the article on page 526.

[14]Burning Characteristics of Pulverized Fuels, by R. A. Sherman, A.S.M.E. Meeting December, 1933.
[15]Edison Electric Institute Bulletin No. A3, August, 1933.
[16]Chicago Entertains Engineers and Societies, Power Plant Engineering, August, 1933. Also May, 1933, page 216.
[17]See Electrical Engineering page 106, February, 1933, and page 601, September, 1933.
[18]A summary of Year's Insulation Research, Electrical Engineering, February, 1933.

New Equipment

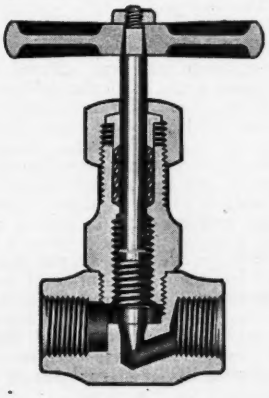
Lunkenheimer Oil Controller

THE LUNKENHEIMER CO. has just developed the Alvor constant level oil control, designed automatically to maintain a constant oil level in ring oiled bearings or anti-friction bearings suitable for oil bath lubrication. The Alvor feeds only enough oil to maintain the required level, and as long as any oil shows in the glass bottle none need be added.

This device operates on the liquid seal principle. It feeds only when the oil level in the bearing drops below the end of the shank, breaking the liquid seal and permitting air to enter the bottle. It will not feed as long as the oil level is at or above the beveled end of the shank.

High Pressure Needle Valves

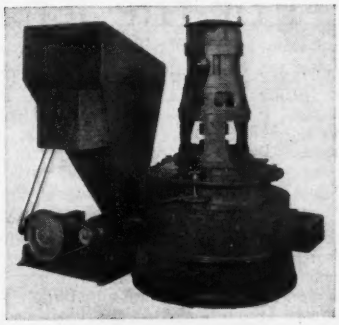
CRANE CO. has placed on the market a newly designed line of high pressure needle valves made from carbon steel or exelloy (a high chrome, stainless iron) and suitable for service in all industries where measuring pressures or volume of flow of fluids or gases is done, and where a gradual release of pressure is necessary to prevent damage to such delicate instruments as pressure gages and meters.



Particularly adaptable to high pressure gage lines on oil service, these valves can also be used on water or gas lines, orifice meters, regulator leads and by-pass connections in power, industrial or chemical plants, in refineries, or on gas and gasoline distributing systems where high pressures at relatively low temperatures are encountered.

Air Separation Pulverizer

THE WHITING CORP., Harvey, Illinois, has developed a line of air separation vertical pulverizers, the latest of which is shown in the above photograph. Air separation is employed and the pulverized material remains in the pulverizing chamber until it is fine enough to be withdrawn by a blower built integral

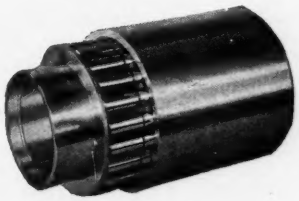


with the pulverizer and driven from the pulverizer shaft. A screw feeder driven through a Link-Belt Variable Speed Transmission (running in oil) may be connected up for automatic control operation. When hot air is introduced into the pulverizing chamber, water cooled bearings are provided. These pulverizers are built in three sizes having capacity of 50 to 3500 lb. per hr.

Roller Bearings

FOR INDUSTRIAL APPLICATIONS, the Fafnir Bearing Co., New Britain, Conn., make a bearing which is of the conventional inner and outer rings and roller cage assembly. Rolls are of high carbon chrome steel and the cage is fabricated from specially form-rolled spacer bar stock with carburized and hardened end rings. Additional capacity is gained by increasing the roll length and by using two rolls of rollers where necessary.

In the cage construction the rollers are held in place by spacer bars riveted to the end rings. An added feature is the use of two-part



rolls which prevents any possibility of skewing. The entire roller bearing assembly is made with a fixed radial clearance to allow for the expansion which takes place when the inner ring is shrunk to the shaft. This clearance also permits the bearing to operate successfully should temperature differentials occur in the actual operation.

These bearings are made in a comprehensive variety for shaft diameters from 3½ to 7⅜ in. inclusive, to cover practically every service for which bearings of this type are suitable.

The pillow block design is furnished with bolted-on end covers to permit easy assembly and disassembly. The conventional type of roller bearing will take little or no thrust load and a bronze plate is usually provided to absorb such thrusts as may occur. With the Fafnir application a standard single roll radial ball bearing is substituted for this bronze plate thrust carrier, and by virtue of its large thrust capacity normal thrust loads in either direction are readily taken care of.

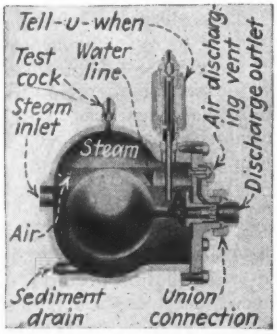
Multiple Seat Union

MADE WITH a serrated copper gasket which mates with the male end to give four separate seats, the new high pressure union announced by the United Superior Union Co., Inc., 29 Ryerson St., Brooklyn, N. Y., are rated for 400 lb. pressure. Bodies are made of malleable iron

cadmium coated after machining as protection against corrosion. Standard unions are made for steam, gas, oil, water and air lines but special gaskets can be provided for special purposes.

New Trap Line

J. E. SWENDEMAN, INC., 171 Camden St., Boston, announce the Model F trap incorporating many new features including: the Tell-U-When, to locate leaky traps and



check their operation in seconds; continuous air vent, with a large capacity and a discharge well above the water seal so as not to be subjected to sediment; the test cock to determine if the trap is handling condensate. The trap is made with renewable valve and seat, making it unnecessary to take the traps apart to service them.

Steam for Making Gas

IN OUR October issue, on page 416 it is stated that the furnaces are provided with a line 4 bricks high along the firing line of Carborundum brick. This is an error. The brick used is "Carbex," silicon carbide brick manufactured by McLeod & Henry Co. of Troy, N. Y.

News From the Field

NORTHERN PUMP CO., Minneapolis, Minn., announces that Hugh L. Rusch, who joined this organization a year and a half ago, has been elected vice president of the company and appointed eastern sales manager with headquarters in the Chrysler Bldg., New York City. Mr. Rusch was formerly supervisor of the Technical Data Section and of the Performance Report Section with the Johns-Manville Corp., and prior to that time was eastern district manager for Arthur C. Nielsen, Inc.

STEEL & TUBES, INC., Cleveland, Ohio, announces that A. V. Grove has been transferred from the Cleveland office to the Chicago office in the sales department, also R. E. Doyle has been appointed sales correspondent and J. F. Keeler sales engineer, both with headquarters in the Cleveland office.

COMBUSTION ENGINEERING CO., INC., announces the appointment of James Cleary, who has been a sales executive of the company for many years, to the position of manager of the Philadelphia sales district and with headquarters at the company's Philadelphia office, 1616 Walnut street; Fred L. Farrell to be manager of the New England sales territory and with headquarters at the company's Boston office, Chamber of Commerce Building; G. O. French as a sales engineer specializing on sales work in connection with the company's fire-tube boilers and all special shop work such as oil refinery equipment, chemical equipment, special alloy vessels, tanks and plate work.

WALTER N. CARGILL, 185 Devonshire Street, Boston, who is sales agent for The Air Preheater Corp., has now been appointed by The Superheater Co., New York, as its sales agent in the New England states for stationary superheaters, economizers, furnace water walls and other Elesco steam plant equipment.

ROBERT S. HALE, Consultant on the Welding of Steel Structures and the remodeling and reinforcing of existing structures by Welding, announces the removal of his office from the Old Colony Building to 1432 W. Lake St., Chicago, Ill.

McIntosh & Seymour Corp., division of American Locomotive Co., Diesel Engines, announces the opening of their New England sales office at 88 Broad street, Boston, Mass., with F. C. MacKrell and J. French Baldwin as representatives.

THE LOUIS ALLIS CO. of Milwaukee, Wis., announces the appointment of four new members to its sales organization as follows: C. F. Cate, 212 North 3rd street, Albuquerque, New Mexico, has been appointed representative for the state of New Mexico. Robert B. Soderberg will represent the company in the state of Connecticut with headquarters at 196 Palm street, Hartford, Conn. N. O. Lawyer has joined the sales organization working out of the company's New York office located at Room 385, 50 Church street. G. W. Connor has joined forces with the Cincinnati office located at 1124 Chamber of Commerce Building.

For the Engineer's Library

HENLEY'S TWENTIETH CENTURY BOOK OF 10,000 FORMULAS, Recipes and Processes. Edited by Gardner D. Hiscox. New edition cloth, size 6 by 9 in. 800 pages. Published by The Norman W. Henley Publishing Co., 2 West 45th St., New York, N. Y., 1933. Price $4.00.

This is an entirely new and revised edition of this book and in its present form more useful than ever before. It is an unusual book but one in which almost any person is bound to find something of interest. It is a book that should prove useful to anybody regardless of his profession or trade, and is a valuable reference for the laboratory, factory, office, workshop or home. It contains thousands of recipes for the manufacture of articles for every day use. It covers every branch of the useful arts and is of value to the photographer, the painter, the electrician, the engineer, the perfumer, the machinist, the electroplater, the jeweler, the paper maker, in fact to anyone interested in the making of any article or compound whatever it may be. In this new edition, special attention has been given to the newer methods, which have been developed in industry recently. New formulas have been added and old ones improved. In order to assist buyers who are not in close touch with commercial centers, a classified buyers' guide has been placed in front of the book for handy reference. Here are found the names and addresses of dealers who handle the various articles needed in compounding the recipes contained in the book. Another feature which will be appreciated by readers who have not had the benefit of technical training, is the glossary of chemical terms and their corresponding names. Last but not least, this new edition contains an excellent index.

STAINLESS STEELS. By Ernest E. Thum. Published by the American Society for Steel Treating, Cleveland, Ohio. 6 by 9 in., 614 pp., cloth. Price, $5.00.

Considering the rapidly increasing importance of stainless steels in all industries, this book is timely and of unusual interest to the average engineer because one does not have to be a trained metallurgist to read and understand it. Individual chapters were prepared by 77 authors, each man was selected for his experience in the particular field on which he writes. These individual chapters were combined and edited by Ernest E. Thum, editor of *Metal Progress*. About two-thirds of the chapters describe the properties of steels, how to fabricate them and what to expect of them. Others tell of the magnitude of successful applications in many industrial lines. Special chapters are devoted to the power industry and the determination of long-time properties at high temperatures, and turbine blade analysis. Other chapters are devoted to classification and index of trade names of steels together with an alphabetical list of manufacturers making them.

AUDEL'S MATHEMATICS and Calculations for Mechanics, by Frank D. Graham. Published by Theo. Audel & Co., 65 W. 23rd St., New York. 700 pages.

This book covers elementary mathematics from arithmetic, plane, solid and analytical geometry through trigonometry, algebra and calculus and into the more complex electrical calculations. There is a chapter devoted to mechanics and one to the slide rule. Problems are presented in a clear, concise manner and are made interesting by the unique illustration of each.

PROCEDURE HANDBOOK of Arc Welding Design and Practice. First Edition. 5¾ by 9 in., 434 pages, 500 illustrations and drawings, semi-flexible simulated leather embossed in gold. Published by the Lincoln Electric Co., Cleveland, Ohio, 1933. Price $1.50.

This book has been designed to present in convenient form for ready reference the basic information on arc welding in its present status. It is an up-to-date book on the subject; of interest to those who are or may be concerned with applications of arc welding in industry. This book presents not only a complete description of the arc welding process in its various forms but also the essential data for its use in welding various types of steels, iron, and non-ferrous metals. The book is divided as follows: I. Welding Methods and Equipment; II. Technique of Welding; III. Welding Procedure, Speeds and Costs; IV. Structures and Properties of Weld Metal; V. Weldability of Metals; VI. Designing for Arc Welded Steel Construction of Machinery; VII. Design for Arc Welded Fabrication of Steel Structures; VIII. Typical Applications of Arc Welding in Manufacturing Construction and Maintenance. The data in the book is authoritative and practical since many users of electric welding equipment coöperated in its compilation.

POWER STATION CHEMISTRY is a 17-page booklet, Publication No. A5, published by the Edison Electric Institute, 420 Lexington Ave., New York City. Among other things this report considers, insofar as they pertain to power station practice, methods of water analysis; slag accumulation in boiler furnaces; electrolytic prevention of scale and corrosion in boilers; chlorination and use of phosphate for boiler water treatment. Price $0.40 to members and their employes; $1.00 to non-members.

STATION PIPING, a 32-page paper bound report, Publication A2, has been issued by the Edison Electric Institute, 420 Lexington Ave., New York City. Among other things this report includes recommendations for the prevention of turbine oil fires, high pressure piping, forged piping and flanges for high pressures and temperatures. Price $0.60 for members and their employes; $1.50 for non-members in U. S. A.

TURBINES is a 39-page report, Publication No. A3, issued by the Edison Electric Institute, 420 Lexington Ave., New York City. The report includes the operating records of a number of large turbines for 1932, data on inspection, blade erosion, lubricating oil fires and tests on a number of large size and high pressure turbines. Price $0.75 to members and their employes; $1.85 to non-members in U. S. A.

PROCEEDINGS of the National District Heating Association for the 23 Annual Convention held June, 1932, are now available and can be obtained from the Association headquarters at Greenville, O., for $3.00. This is a 6 by 9 in., 394 page cloth bound volume containing the various committees' reports and papers. Station operation, feedwater treatment, corrosion, fuels, boilers and furnaces are some of the plant problems discussed. The balance of the book is concerned with general district heating problems, one of the interesting papers being the design of a hypothetical distribution system showing the different type systems that can be used and their relative costs.

CONTROL OF QUALITY factors in the manufacture of steel by the basic open hearth process is covered in a booklet, Carnegie Controlled Carbon Steels, recently published by the Carnegie Steel Co., Pittsburgh, Pa. This booklet tells the details of how control in manufactured steel is effected, shows some actual photographs and chemical analyses of types A, B, and C, steels of different grades quenched at different temperatures.

INFORMATION for Engineers and Designers on the new CB Sections to be available April 1, 1934, contains a supplement to the Pocket Companion published by the Carnegie Steel Co., Pittsburgh, Pa. Although these sections will not be available until April of next year, the booklet is published now so as to make data on these sections available for new design.

PORTABLE COMPRESSORS of 240 and 120 c.f.m. displacement are described in a new bulletin recently issued by the Worthington Pump & Machinery Corp., Harrison, N. J.

REFRIGERATION COMPRESSORS of all sizes, equipped with feather valves, are described in a new bulletin, L-600 S B 2 published by the Worthington Pump & Machinery Corp., Harrison, N. J.

LOW PRESSURE refrigerating units in more than 20 sizes from ¼ hp. up to meet the needs of all commercial users are described in a new bulletin, No. 97-A, published by the Frick Company, Waynesboro, Pa. Each machine is a complete condensing unit with compressor, electric motor, starter, V-belt drive, condensers, receiver, traps, valves, pressure gage, all mounted on a substantial iron base and may be charged with either methyl chloride or freon. They are also available for gasoline engine drives.

COMPLETE AUTOMATIC control for steel hardening by the Vapocarb Hump Method is described in detail in Bulletin L-960 just issued by Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa. This method brings under complete control three vital factors on which correct hardening depends; the quench point; rate of heating and furnace atmosphere. It is used in the hardening of steels for such purposes as tools and dies.

VERTICAL DUPLEX refrigerating compressors for direct or belt drive are described in a new bulletin issued by the Worthington Pump & Machinery Corporation, Harrison, N. J. Portable compressors of 310 cu. ft. displacement are described in a separate bulletin.

DATA ON STEAM STORAGE systems and the A. V. A. Regulator; valves together with data from representative installations are included in two new booklets recently issued by the Ruths Steam Storage, Inc., New York.

THE BROWN INSTRUMENT CO., Philadelphia, has published a new catalog describing its new line of thermometer and pressure gages. These instruments are available in indicating, recording and controlling types with new features such as universal case, electric chart drive, automatic pen release, combination door handle and lock and toggle switch for chart drive, all furnished as standard without extra cost. The catalog is identified as No. 6702.

TABLE for the rapid evaluation of the square root of the sum of the squares of two numbers by W. J. Seeley, Duke University, Durham, N. C., is published by the Engineers Publishing Co., Philadelphia, and can be obtained from the publisher for 10 cents a copy.

INDUSTRIAL TYPE Jones Tachometers are described in a recent bulletin issued by the Texair Instrument Co., 465 Eighth Ave., New York City.

THE STRONG, CARLISLE & HAMMOND CO., Cleveland, Ohio, in Bulletin No. 151, gives essential information on its pressure regulating valves, pump valves and strainers which is helpful to an engineer in selecting his equipment.

RUGGLES-KLINGEMANN MFG. CO., Salem, Mass., is distributing a new bulletin designated as No. 53 showing the company's line of solenoid and pressure trip valves which have a wide application in connection with turbine installations and other steam driven units; also with oil burning equipment.

REPUBLIC STEEL CORP., Massilon, Ohio, has just published a booklet dealing with Enduro 4-6 per cent chromium steels. These steels possess resistance to corrosion, acid attack and scaling at elevated temperatures sufficient to render them adapted for a number of applications, particularly in oil refining industry. They can be rolled, formed, drawn, forged, welded or riveted into almost any shape.

SINGLE STAGE horizontal steam and motor driven compressors of 7 and 9 in. stroke are described in a bulletin recently issued by Worthington Pump & Machinery Corp., Harrison, N. J. Another bulletin gives information on the Worthington-Gamon beer meter.

TWENTY-SIX loose pages for insertion in the Carnegie Steel Company Sheet Piling booklet are now available at headquarters of the company at Pittsburgh, Pa. These sheets replace older ones of the same number and are for a new standardized series of steel sheet piling which became available November 1, 1933.

ENAMELITE, an asphaltic mastic for the application of cork insulation to concrete and brick walls, is described in a folder just issued by the Presstite Engineering Co., 4067 Park Avenue, St. Louis, Mo.

NEW INDICATING LAMPS, for signal light indication on switchboards, control panels, etc., are described in a 4-page circular, GEA 1804, recently issued by the General Electric Co. These little lamps complete with receptacles, resistors, and color caps are of a new type perfectly interchangeable, long life and low wattage.

THE FOXBORO CO., Foxboro, Mass., is distributing its new bulletin No. 195 which deals with pressure instruments of the recording, controlling and indicating type. The catalog describes their complete line of instruments for this type of work and accompanies the text matter with detailed photographs and drawings.

Power Plant Construction News

Ala., Decatur — Goodyear Tire & Rubber Co., Akron, Ohio, plans installation of electric power equipment in connection with an expansion and improvement program at tire fabric mill at Decatur, formerly the property of the Connecticut Mills, recently acquired. Cost about $100,000.

Calif., Montebello — Board of City Trustees is planning construction of new municipal electric light and power plant, using Diesel engine-generator units. A transmission line and distributing system are proposed. Entire project will cost about $120,000, and financing in that amount is under way.

Colo., La Junta—City Council is considering construction of new municipal electric light and power plant. Surveys and estimates of cost will be made at early date. Franklin P. Wood, 1441 Welton Street, Denver, Colo., is consulting engineer.

D. C., Washington — Kenilworth Brewing Co., care of Hymen Goldman, 635 Indiana Avenue, N. W., recently organized, plans installation of electric power equipment in new brewing plant at Kenilworth, a suburb of the city. Entire project will cost about $100,000.

Ga., Reidsville—State Prison Department, Atlanta, Ga., plans construction of new power plant at proposed multi-unit State Penitentiary, Reidsville. Project will also include a mechanical laundry and other mechanical departments. Entire program will cost about $1,500,000. Yucker & Howell, Rhodes Haverty Building, Atlanta, are architects; Robert S. Fiske, Walton Building, Atlanta, is consulting engineer.

Ill., Lockport—Board of Directors, Sanitary District of Chicago, 910 South Michigan Avenue, Chicago, is considering extensions and improvements in power plant at Lockport. Estimated cost about $800,000, with equipment. Proposed to arrange for Federal loan at early date.

Ind., Indianapolis — Gold Medal Brewing Co., 1300 Madison Avenue, plans installation of electric power equipment in connection with a modernization and expansion program. Entire project will cost close to $100,000. McGuire & Shook, Architects & Builders Building, city, are architects. F. W. Hoch is president.

Iowa, Lamoni—Town Council is considering construction of new municipal electric light and power plant, estimated to cost $100,000, with equipment. Special election will soon be held to approve bond issue.

Ky., Athertonville—Cummins Distilleries Corporation, 626 Main Street, Louisville, Ky., A. J. Cummins, head, plans installation of electric power equipment in connection with expansion and modernization program at plant at Athertonville. Entire project will cost about $175,000. Ford, Bacon & Davis, Inc., 39 Broadway, New York, N. Y., are consulting engineers.

Ky., Shelbyville—City Council is arranging for a bond issue of $125,000 for construction of new municipal electric light and power plant. Plans will be completed at once.

Md., Havre de Grace—Hartford Pure Rye Distillers, Inc., H. Edgar Hough, president, recently organized, plans installation of electric power equipment in new local distillery. Former textile mill has been acquired and will be remodeled for distilling plant. Cost about $75,000.

Mass., Bridgewater—Department of Correction, State House, Boston, has plans under way for new electric power plant at State Farm, Bridgewater, estimated to cost over $100,000, with equipment. Densmore, LeClear & Robbins, 31 St. James Avenue, Boston, are architects.

Mass., Medford — State Department of Mental Diseases, State House, Boston, Mass., plans extensions and improvements in power plant at State Hospital, Medford. Estimated cost $133,000, with equipment. W. & L. Engineering Co., 694 Washington Street, Boston, is engineer.

Minn., Moorhead — City Council is having plans drawn for extensions and improvements in municipal electric light and power plant, including installation of new boilers, stokers and other equipment. Work is estimated to cost close to $75,000. Financing will soon be arranged. Ralph D. Thomas, 1200 Second Avenue South, Minneapolis, Minn., is consulting engineer.

Mo., Stanberry — Board of Public Works is arranging financing for $98,000, for a new municipal electric light and power plant, and plans to begin work at early date. Henrici-Lowry Engineering Co., 114 West Tenth Street, Kansas City, Mo., is consulting engineer.

Mo., Trenton—City Council has authorized plans for new municipal electric light and power plant, and distribution system. Entire project estimated to cost $250,000. Bond issue will be arranged. Henrici-Lowry Engineering Co., 114 West Tenth Street, Kansas City, Mo., is consulting engineer.

Neb., Lincoln—M. L. Rawlings Ice Co., Sixth and J Streets, plans new one-story and basement addition to ice-manufacturing plant, 42 x 100 ft. Cost about $25,000, with equipment. James Tyler, 1629 South Sixteenth Street, is architect.

N. J., Camden — City Commission will have plans drawn for new municipal electric light and power plant. Bond issue of $10,000,000 authorized at recent general election.

N. D., Enderlin—Common Council is arranging for Federal loan for $120,000 for new municipal electric light and power plant, using Diesel engine-generating units, of which about $60,000 will be expended for equipment. About $21,000 will be used for an electrical distributing system.

Ohio, Columbus — Hoster Brewing Co., 3240 A. I. U. Building, H. C. Tuller, secretary, plans one-story boiler plant at new multi-story brewing plant on local site. Will install electric power equipment for brewery service. Entire project will cost about $300,000. Albert Kahn, Inc., City Center Building, Detroit, Mich., is architect and engineer.

Ohio, Columbus—City Council plans early construction of new addition to municipal electric light and power plant, with installation of new equipment. Cost $824,000. Bonds will be issued in sum noted, approved at recent general election.

Ohio, Sandusky — City Council will soon have plans completed for a new municipal electric light and power plant to cost $1,400,000. Citizens have authorized bond issue in that amount for project.

Okla., Kaw City—T. C. Hughes, 1626 Baltimore Street, Tulsa, Okla., consulting engineer, representing a company now being organized, has preliminary plans under way for a new hydro-electric generating plant on Arkansas River near Kaw City, estimated to cost about $2,000,000, with transmission system. Station will be equipped for initial capacity of 30,000 hp. Financing is being arranged.

Okla., Muskogee—City Council is arranging financing for $1,260,000 through Federal loan, fund to be used for construction of new municipal electric light and power plant. Plans will be drawn by Burns & McDonnell Engineering Co., 107 West Linwood Boulevard, Kansas City, Mo., consulting engineer.

Bonneville, Ore.—Attention has been called to an error in the Power Plant Construction News of November. Item said Bureau of Reclamation, Denver, Colo., would prepare plans and call for bids. This work is being carried out by the United States District Engineer's office in Portland, Ore. C. I. Grimm, principal civilian engineer, is in charge of the work. Major Chas. F. Williams is District Engineer in Portland and Lt. Col. Thomas M. Robins heads the U. S. Engineer's office, Pacific Division, San Francisco, Cal.

R. I., North Tiverton—New England Terminal Co., plans rebuilding of oil storage and distributing plant, recently destroyed by fire with loss of about $800,000, including installation of pumping machinery, steel tanks and other equipment. Louis D. Pierce is one of heads of company.

Texas, Corpus Christi—South Texas Live Stock Association, care of Jonas Weil, Corpus Christi, president, recently organized, plans installation of electric power equipment, conveying and other mechanical-handling equipment in new local meat-packing plant. Cost over $400,000.

Texas, Goose Creek — Common Council has made application for Federal loan of $125,000 for construction of new municipal electric light and power plant. Proposed to begin work at early date. David M. Duller, Second National Bank Building, Houston, Texas, is consulting engineer.

Wash., Seattle—American Distillery Corporation, Seattle, care of Carl J. Kiefer, Schmidt Building, Cincinnati, Ohio, consulting engineer, plans construction of one-story power house at proposed new distilling plant at Seattle. Electric power equipment will be installed for distillery service. Entire project will cost over $400,000.

Wis., Chippewa Falls—State Board of Control, Madison, Wis., A. W. Bayley, secretary, is planning construction of new power plant at Northern Wisconsin Training School, Chippewa Falls. Cost about $245,000, with equipment. Financing is being arranged.

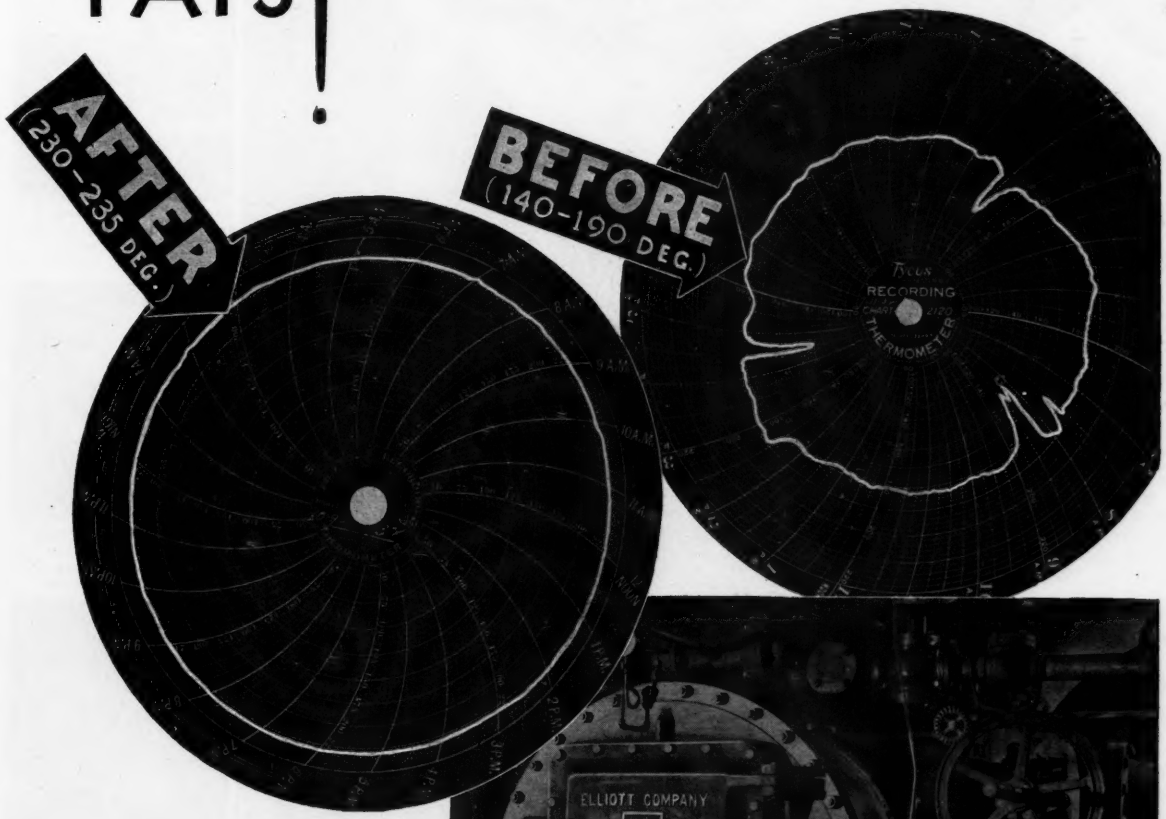
IMPROVED feed water heating PAYS!

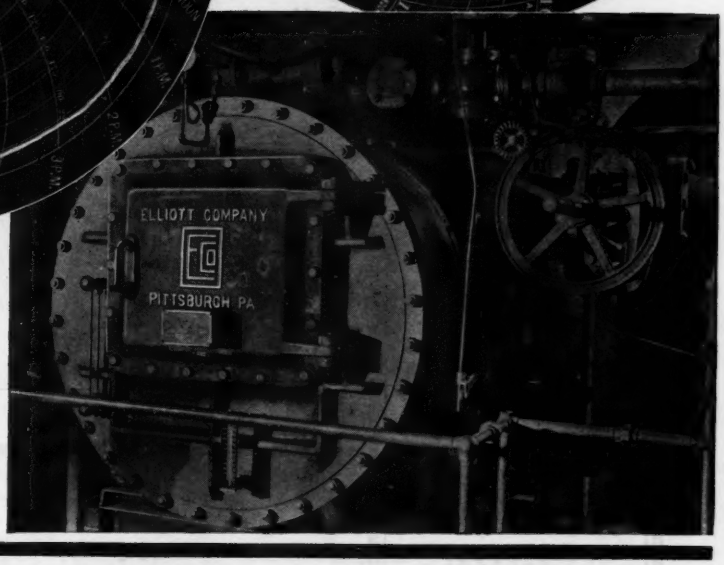
The charts below tell an interesting story. In this particular plant an open heater had been delivering water averaging 180° F. An Elliott deaerating heater was installed. Operating under exactly the same conditions as the open heater, it delivered water, as shown by the chart in the smooth line, at 230° F.

Resulting savings more than paid for the Elliott deaerating heater within a year.

An Elliott deaerating heater justifies itself on the basis of feed water temperatures alone, for it heats to the saturated temperature of the steam supplied, which means perfect or best possible heating performance. In addition, the removal of dissolved oxygen and other gases eliminates corrosion troubles—another dollars and cents advantage.

Such two-way savings deserve your careful investigation.





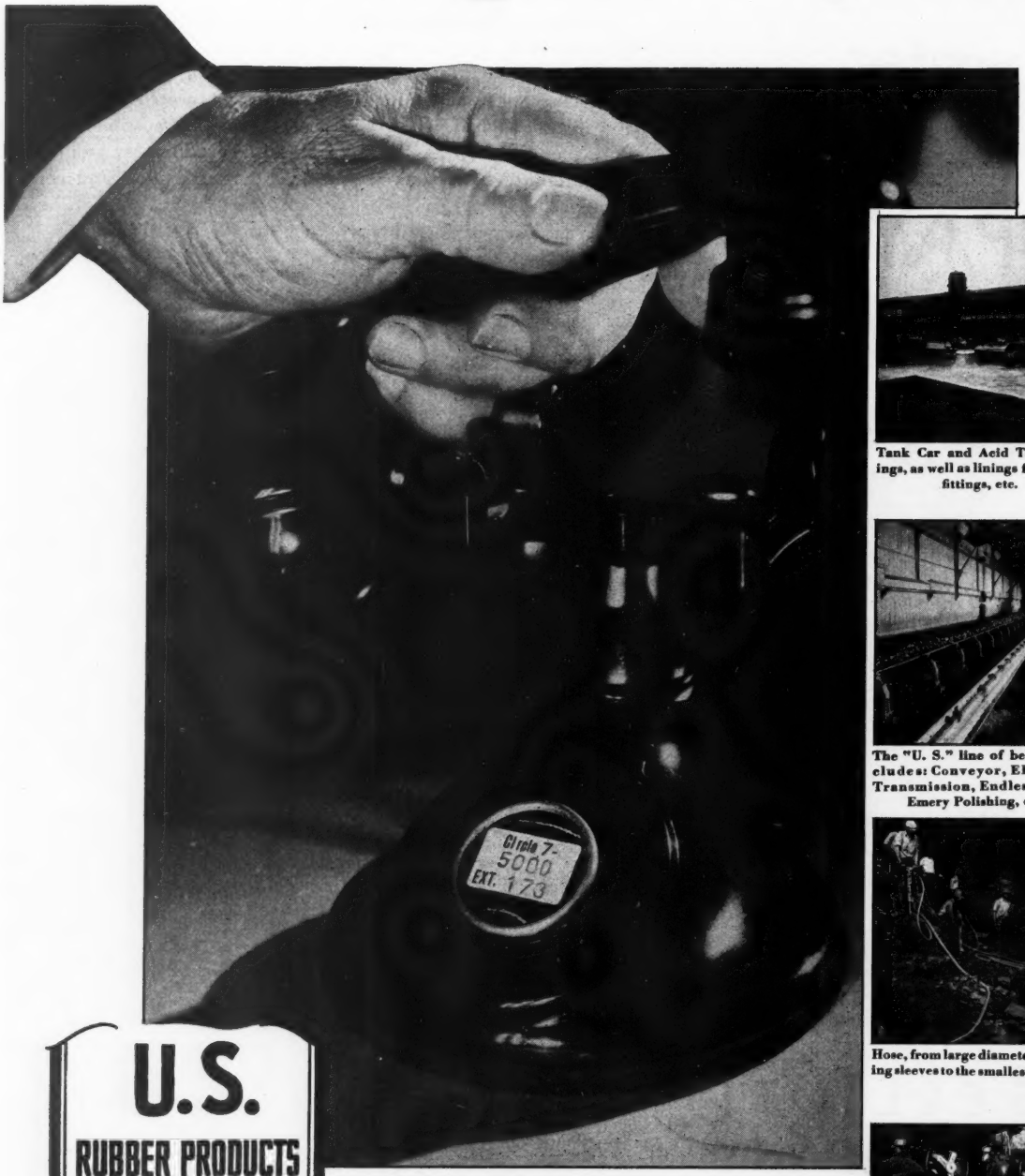
ELLIOTT COMPANY
PITTSBURGH, PA.
Heat Transfer Department
JEANNETTE, PA.
District Offices in Principal Cities

NRA MEMBER U.S. WE DO OUR PART

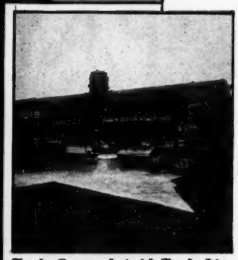
N-919

ELLIOTT DEAERATING HEATERS

The Simplest of all



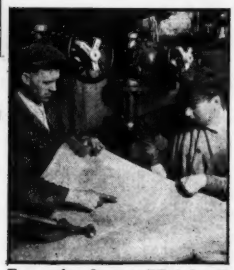
U.S. RUBBER PRODUCTS GIVE *THAT EXTRA* SERVICE



Tank Car and Acid Tank Linings, as well as linings for pipes, fittings, etc.

The "U. S." line of belting includes: Conveyor, Elevator, Transmission, Endless, Acid, Emery Polishing, etc.

Hose, from large diameter dredging sleeves to the smallest tubing.



From the famous "Rainbow" Sheet Packing to high and low pressure Rod and Valve Stem Packings.

NRA WE DO OUR PART

SPECIFICATIONS

Specify duck-weight, adhesion, tensile, elongation, gravity, burst–and you merely establish standards below which a product must not fall.

But those *extra* values above test or specification requirements, that are the fruit of long experience, supreme skill and a complete knowledge of service conditions and demands, are beyond the scope of the most rigid specifications.

Your only assurance of getting these plus values is in the selection of a manufacturer.

In the purchase of industrial rubber products your simplest–and safest–specification is..."Call U. S."

—United States Rubber Company—

1790 BROADWAY NEW YORK CITY

BRANCHES IN ALL INDUSTRIAL CENTERS

POWER PLANT ENGINEERING December 1933

No. 3 of a series of advertisements addressed to engineers.

Inside MONEL METAL Facts

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL STREET, NEW YORK, N. Y.

The Goulds Hydroil Centrifugal Separator. Monel Metal parts shown in the foreground. From left to right, are forged bowl shell, wing distributor, ring dams, bowl nut, forged dividing cone, forged bowl base. All, except the cast wing distributor, are machined from special forgings or bar stock Monel Metal.

GREAT STRESSES AND CORROSION FOILED IN GOULDS SEPARATOR

Makers of Goulds Pumps (Seneca Falls, N. Y.) know that even water has a corrosive effect on steel and iron products.

So, in building equipment to handle this and other more highly corrosive liquids, they must take special precautions.

See how they meet the problem of corrosion in their Hydroil Centrifugal Separator.

Monel Metal on Guard*

For every internal part of this separator that comes in contact with liquids, Goulds uses Monel Metal. In that way it is effectively fortified against rust and corrosion. And also against severe dynamic stresses plus hydraulic pressures.

For Monel Metal has the strength of steel. It is also amenable to the special and intricate forging operations, essential for producing such equipment.

It is readily machined to precise tolerances.

And these working characteristics are reflected in the *price* of Goulds separators.

Over an oil-handling separator with *steel* parts, *Monel Metal increases the price less than 4 per cent.*

DISC AND RING SEAT OF THIS SOOT BLOWER NEED LESS REGRINDING

Drop forged Monel Metal trim is standard equipment in Diamond appliance

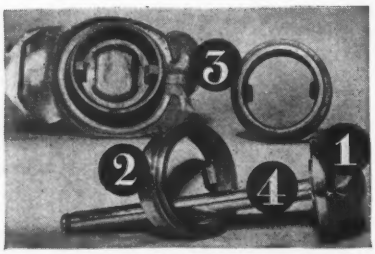
Steam rushing through these vital parts of the Diamond Soot Blower has a hard time trying to erode them.

And, it doesn't get anywhere trying to distort them. For they are drop forged from Monel Metal so that steam, even under highest pressure, meets obstinate and long life resistance.

Neither steam nor condensate can rust these parts when idle. For Monel Metal is absolutely rust-proof.

Besides giving longer life to the vital parts, Monel Metal reduces to a minimum the need and expense of regrinding. Stems and disc nuts are machined from rolled Monel Metal bar.

For these sound reasons vital parts of Monel Metal are standard equipment on the Diamond Soot Blower.



Drop forged Monel Metal (1) *disc and* (2) *seat ring of Diamond Soot Blower.* (3) *Two steps in drop forging of seat ring before machining and threading.* (4) *Stem, with lock nut for attaching to disc, machined from rolled Monel Metal bar stock.*

THESE PRESSURE FITTINGS ALWAYS EASY TO DISMANTLE

There are two reasons why the Parker Appliance Co. (Cleveland, Ohio) machines pressure fittings from Monel Metal:

First, because Monel Metal has the steel-like strength necessary to withstand high pressures.

Secondly, because its absolute immunity to rust makes dismantling always an easy job.

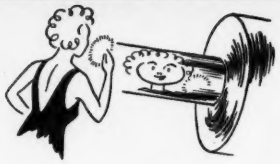
Note that the flared end of the tubing in the illustration on the right is locked firmly between male and female cones in opposite halves of the fitting.

The larger nipple of the fitting is equipped with a taper thread for steam tight attachment to the pipe line or boiler wall.

This type of fitting is particularly satisfactory for connecting seamless Monel Metal, Nickel or copper tubing to high pressure steam flow meters.

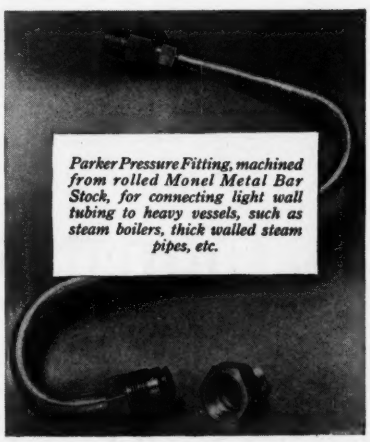
*Monel Metal is a registered trade-mark applied to an alloy containing approximately two-thirds Nickel and one-third copper. Monel Metal is mined, smelted, refined, rolled and marketed solely by International Nickel.

CAN YOU BEAT IT?



"When making an inspection at our St. Charles Plant recently," writes Master Mechanic John F. Nelson of The Cable Company, "I noticed the piston rod in one of our pumps that formerly gave us a lot of trouble. It showed absolutely no signs of wear and was bright as a mirror, although this pump has been running continuously night and day for five years. I asked our Plant Engineer how soon he would have to replace it and his reply was —'Never.'"

Can you beat or equal, this pump rod record? If you know of a comparable case of Monel Metal pump rod performance we'd like to hear about it. Please write and tell us.



Parker Pressure Fitting, machined from rolled Monel Metal Bar Stock, for connecting light wall tubing to heavy vessels, such as steam boilers, thick walled steam pipes, etc.

WORLD-WIDE . . . AND IN YOUR PLANT

A Vital Cog

in cost control

Today, labor costs are higher! Raw material costs are higher! Selling costs are higher! Now is the time to profit by the experience of world-wide plants in every industry and let Gargoyle Lubricants help reduce your major *plant* costs.

For, in your plant, too — Gargoyle Lubricants can reduce power costs 3% to 10%. They can lower your maintenance and repair expense. They may help speed up your production schedules. They'll certainly insure you against machinery shutdowns.

The cost of lubrication is a trifling one — probably less than 1% of your total costs of conversion. Yet this seemingly insignificant item controls major costs in your plant. Plant records, written in every language, prove that Gargoyle Lubricants *can easily save you many times your total annual cost of oil.*

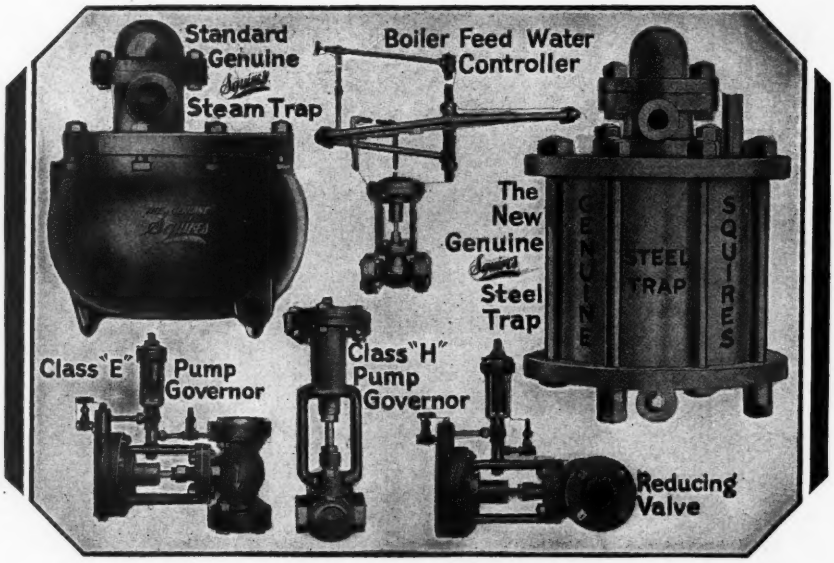
Any Socony-Vacuum representative will be glad to show you lower-cost records made by leading plants in your own industry . . . to suggest means by which you can lower today's costs in *your* plant.

Socony-Vacuum Corporation, 26 Broadway, New York City. Branches and distributors throughout the world.

SOCONY-VACUUM
CORPORATION

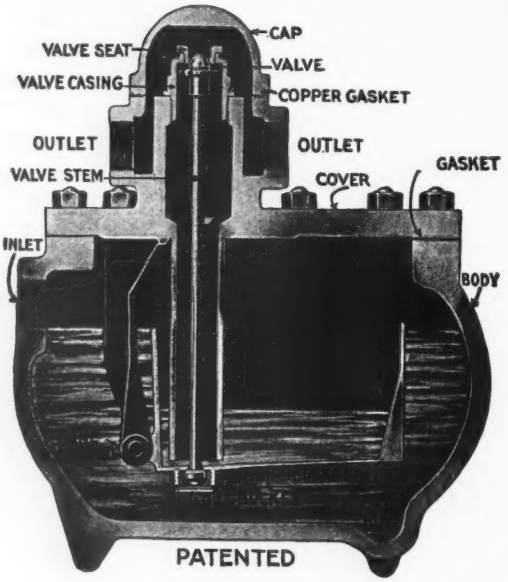
NRA
WE DO OUR PART

Send for Catalog E for full information about these Specialties



Install SQUIRES Specialties

they'll help cut operating costs to the bone



Interior view of the Standard Genuine Squires Steam Trap. Parts are accessible for inspection or change without breaking pipe connections. Cast iron bucket is hinged by means of tapered bearings to an open bronze bearing. No floats, no levers, no joints to fill with dirt in this trap. Valve cannot be displaced; stem never requires packing. Compare valve orifices with those of other makes for capacities instead of pipe connections.

You'll find the notably trouble-free, heat-saving service of Genuine Squires Specialties a decided help in your present effort to trim operating costs to the bone.

Genuine Squires Traps, covering the entire range of trapping requirements, and the other Squires Specialties have been in use in the country's outstanding central stations and industrial plants for the last thirty years.

Squires Pump Governors include a type for every service; Reducing Valves give exact reductions from highest pressures to any low pressure desired; Boiler Feed Controllers help boilers to give increased efficiencies.

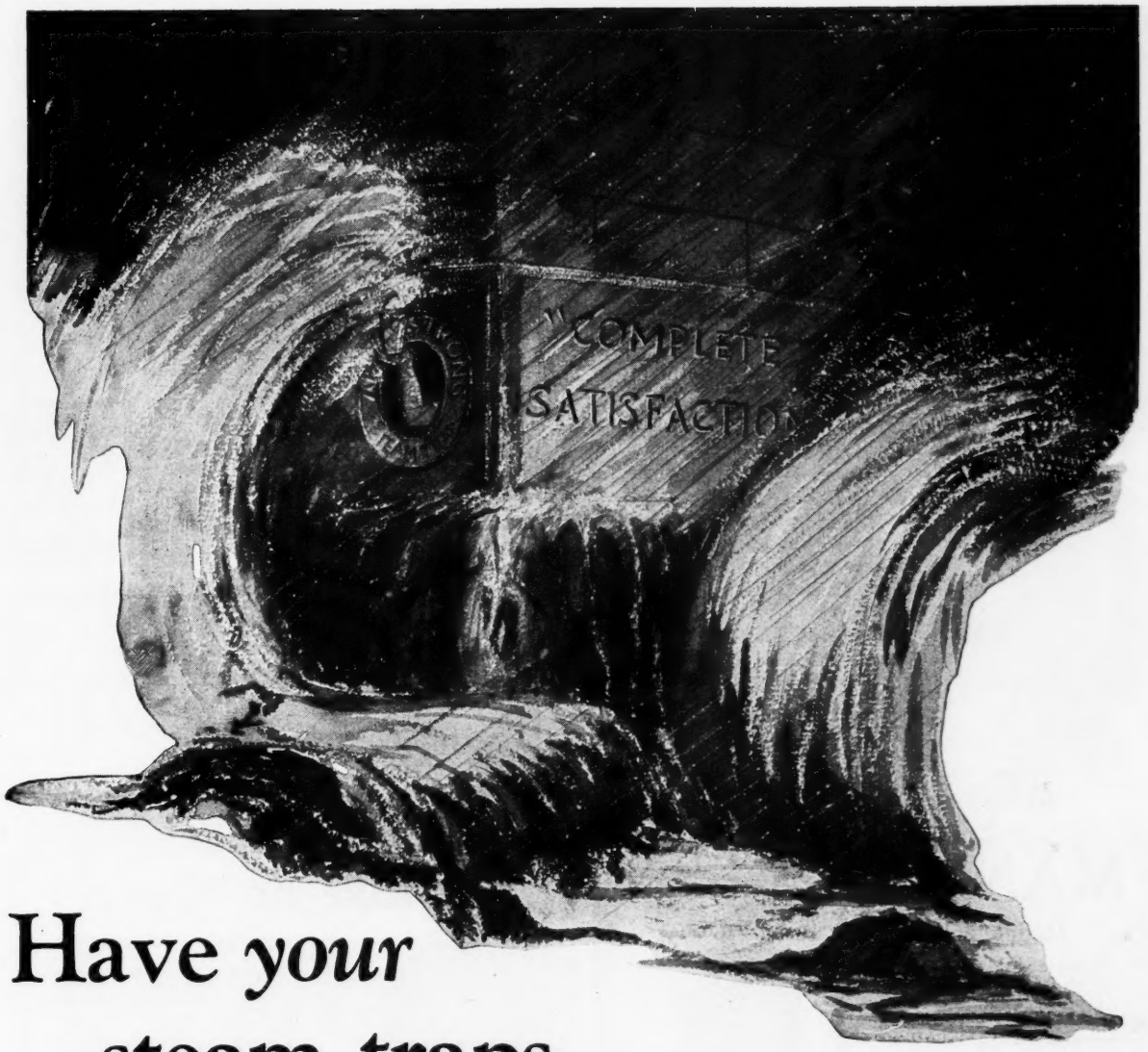
Write today for the details about these Specialties. The quick and certain way to benefit by ALL the steam that's being paid for is to use Genuine Squires.

Insist on the Genuine Squires

Steam Specialties

THE C. E. SQUIRES COMPANY

E. 40TH ST. & KELLEY AVE., CLEVELAND



Have *your* steam traps stood the test?

WHEN the going has been tough, have your steam traps met every requirement? Have they piled up annoyance, expense and waste or have they built a record of dependable service with little cost and trouble on your part?

Armstrong Steam Traps have come through severe tests for more than 20 years. They have saved money and have speeded up heating and processing for thousands of leading users.

You can enjoy "complete satisfaction" in steam trap service—the Armstrong guarantee — by selecting an Armstrong trap for every need, by utilizing the Armstrong service organization to the fullest extent, and by judging traps on the basis of performance and not on such false standards as pipe sizes or cost per pound.

Your nearest Armstrong representative will welcome an opportunity to help correct any troubles you have had with traps and to put one or more Armstrongs at your service for 90 days' free trial.

ARMSTRONG · "INVERTED BUCKET" STEAM TRAP

ARMSTRONG MACHINE WORKS

810 Maple Street, Three Rivers, Michigan

PPE12 Gray

WHY THROW GOOD MONEY AFTER BAD?

Don't waste money by trying to keep in repair obsolete, wasteful float or bucket steam traps, each draining condensation from a number of steam heated units.

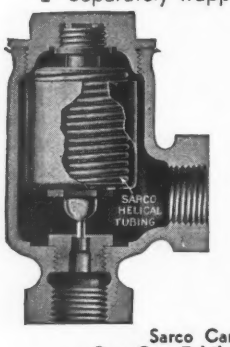
There is a better, more modern, more economical way.

SARCO STEAM TRAPS

are small enough and cheap enough to justify a separate trap at every point where condensation forms.

This method of Individual Trapping has these vital advantages:

1. The Sarco Trap takes up no floor space. It goes into the line like a fitting.
2. Separately trapped—no coil can be water logged by back pressure in the returns from a neighboring unit.
3. No long connecting lines to traps to waste heat by radiation and overheating work rooms.
4. Nothing but hot steam in the machines—nothing but cool condensate in the return pipes.



Further details in our catalog No. B-95. Write for a copy, free memo book and our free trial offer. It will convince you.

SARCO CO., Inc.
183 Madison Ave., New York, N. Y.
Branches in Principal Cities
Sarco Canada Limited, Federal Bldg., Toronto, Ont.

SARCO CO., INC.,
183 Madison Ave., New York, N. Y.
☐ Send a Sarco Steam Trap on 30 days' free trial.
Size.....for pressure.....lbs.
☐ Send Catalog No. B-95.
Name .....
Address .....
City..... State.....

See Our Exhibit at the Chemical Show, Grand Central Palace, New York, Booth No. 34, Dec. 4th to 9th

MANZEL FORCE FEED LUBRICATORS

Model "25"

Provide positive, economical lubrication for cylinders and bearings with minimum attention.

Deliver fresh, live oil at the desired rate, regardless of pressure, temperature, engine speed, or kind of oil used.

Available with ratchet or rotary drive.

Write for Catalog No. 31

MANZEL BROTHERS CO.
327 Babcock St. Buffalo, N. Y.

You take no chances

in specifying Hercules Seamless Copper Floats. More than 615,000 in service offer convincing proof of the unfailing, low-cost service they deliver. Guaranteed for working pressures up to 350 lbs. Write us about your float problems.

HERCULES FLOAT WORKS
215 Franklin St., Springfield, Mass.

HERCULES

THE ORIGINAL
SEAMLESS COPPER FLOATS

POSITIVE RESULTS

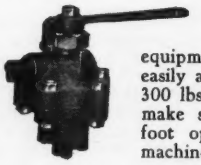
In plants where a definite number of air changes must be maintained the BURT Fan Ventilator is widely favored. Does the work of five or more gravity ventilators. Ask Burt Engineers to send you our Fan Bulletin and make recommendations and layout for your job.

BURT Direct Connected Fan Ventilator

THE BURT MFG. CO.
Ventilators—Oil Filters—Exhaust Heads
44 E. SOUTH ST., AKRON, O.

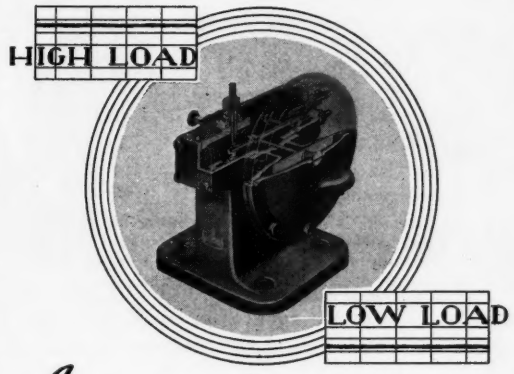
NICHOLSON

Two, Three and Fourway Valves



For operating air, steam, oil or water cylinders on all kinds of equipment. Flat disc type that operates easily and holds tight. For pressures up to 300 lbs. Write for Bulletin No. 1131. Also make special purpose valves—solenoid and foot operated, as well as plastic molding machine valves.

W. H. NICHOLSON & CO.
120 Oregon St. Wilkes-Barre, Pa.



Askania Control *is equally*

TRUE *and* UNIFORM

Regulation by means of the Askania System is fully metered, continuously responsive to the regulating impulse and governs throughout the entire working range without adjustment or attention. For details write to.....

H.A.BRASSERT & CO.
310 S. MICHIGAN AVE. CHICAGO, ILL.

Always Properly Filled -Never to Overflowing

is the Tank that is served by a FULTON Altitude GOVERNOR

CF

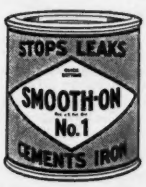
THE Fulton Tank or Altitude Governor is designed for installation on a single line to an elevated tank, permitting full flow upward so long as the storage water is below a fixed level, permitting full flow downward in any emergency, but ordinarily and in normal use keeping inlet and outlet alike under control. Water will flow in either direction through the valve, according to whether pump pressure or tank pressure is greater at the moment. Thus the proper level is maintained, in the interest of economy and safety. Ask for descriptive circular.

THE CHAPLIN-FULTON MFG. CO.
28-40 Penn Ave., Pittsburgh, Pa.
Manufacturers also of VIGILANT Water Regulator and Other Steam Specialties. Interesting Catalog on request.

This emergency repair with SMOOTH-ON No. 1 avoided a costly shut-down

A PIECE broke out of one end of the reducing tee in this line in disassembling and no new fitting could be obtained. The piece was plastered back with Smooth-On No. 1 and more tamped under a metal ring put over the flange end as a reinforcement. This repair lasted 5 years until the equipment was discarded, and was still perfect then.

Instances where Smooth-On No. 1 protects the Engineer's reputation and is the means of avoiding excessive shutdown are occurring every day. *Be prepared.*

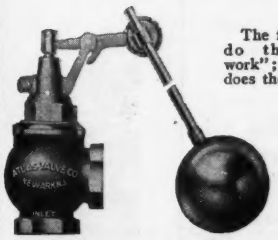


Get Smooth-On No. 1 in 1, 5, 25 or 100 lb. package from any supply house, and write to us for a free copy of the Smooth-On Instruction Book.

SMOOTH-ON MFG. CO., Dept. 31
570 Communipaw Ave., Jersey City, N. J.

Do it with **SMOOTH-ON**

This is a **POWER** Float Valve



The float does not do the "heavy work"; POWER does the work.

It is Auxiliary Operated

It always works, dependably, regardless of the size of the valve, and regardless of the pressure. The float merely operates a pilot valve which is extremely sensitive.

The Atlas Float Valve is positively guaranteed to be drop tight. It can be installed within the tank or in the supply line outside of the tank and operated by a float in the tank. Strong and durable. Sizes ½" to 2", all bronze, 2½" to 8", iron body, bronze mounted or all bronze, globe or angle, screwed or flanged.

We make regulating valves for every service. See list in the accompanying coupon. If the list doesn't contain what you want—inquire.

ATLAS VALVE COMPANY
REGULATING VALVES FOR EVERY SERVICE
291 South St., Newark, N. J.

Atlas Valve Co., 291 South St., Newark, N. J.
Please send information on the following Atlas products without obligating me in any way:—

- ☐ Float Valves
- ☐ Controller Feed Water Regulator
- ☐ Temperature Regulators
- ☐ Reducing Valves
- ☐ Exhaust Control System
- ☐ Pump Governors
- ☐ Bronze Fittings
- ☐ Unions
- ☐ Thermostats
- ☐ Balanced Valves
- ☐ Control Valves

Name .....
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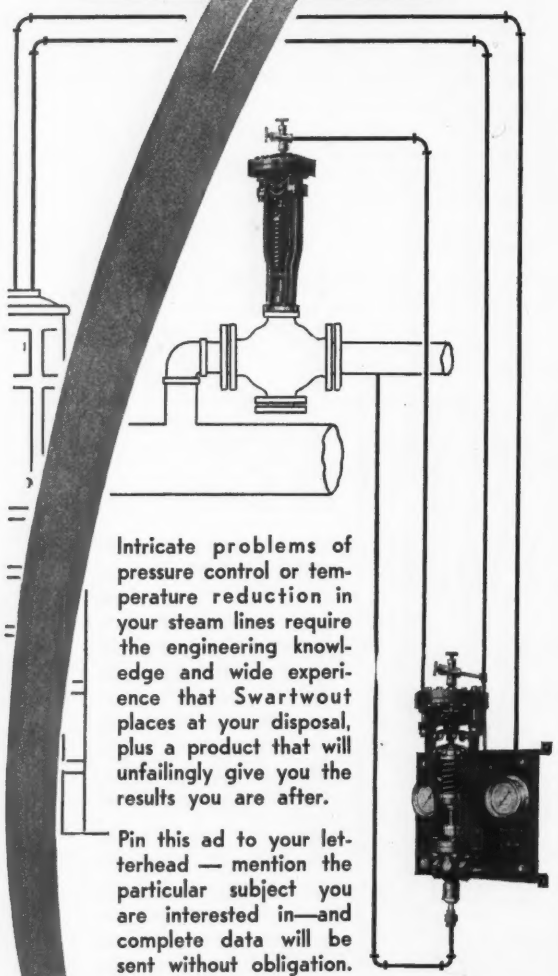
Street .....
City ..... State.....

For *Exacting* TEMPERATURE *and* PRESSURE REGULATION *Consult*



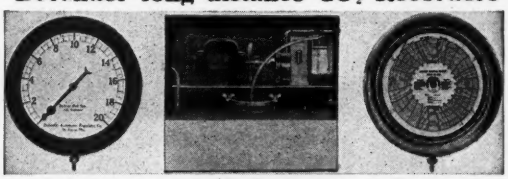
Intricate problems of pressure control or temperature reduction in your steam lines require the engineering knowledge and wide experience that Swartwout places at your disposal, plus a product that will unfailingly give you the results you are after.

Pin this ad to your letterhead — mention the particular subject you are interested in—and complete data will be sent without obligation. Do it today.

Swartwout

THE SWARTWOUT COMPANY
18511 EUCLID AVE.- CLEVELAND, OHIO

Defender long distance CO_2 Recorders



Indicator Analyzer Recorder

Defender Patented CO_2 Recorders are by far the simplest, smallest in size and lowest in price and are the finished product of our twenty years' experimental and research work.

Bulletin 9-A shows stationary models and Bulletin 9-B shows the Portable models in 1, 2 and 3 pen Instruments

DEFENDER AUTOMATIC REGULATOR CO., St. Louis, Mo.

SIMPLEX Boiler Feed METERS

are of the Venturi type; read accurately over a wide range; indicate, record and totalize the flow. Write for Bulletin 32-A.

SIMPLEX VALVE & METER CO.
6751 Upland St., Philadelphia, Pa.

Brown Electric Flow Meter

on the Inductance Bridge Principle

Pyrometers
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Draft Gauges
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Pressure and Vacuum Gauges
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Indicating, Recording, Controlling, Signalling
Write for Catalogues.

THE BROWN INSTRUMENT COMPANY
4491 WAYNE AVENUE PHILADELPHIA, PA.
Offices in 22 Principal Cities

Lonergan

Pressure Gauge Model "BOE"

Pressure Gauge, Model "BOE", strong, accurate, well built, is a worthy member of "The Lonergan Line" of appliances which have been protecting steam, hydraulic, gas, oil, air and ammonia installations since 1872.

Wherever you are, there is a Lonergan engineer near you. His knowledge is at your disposal without obligation. Write to us.

J. E. LONERGAN CO.
217 Race St. Philadelphia, Pa.

Ask for Catalogue of "The Lonergan Line"

Since 1872
"The Lonergan Line"

300 specialties for power plants

BAILEY METERS

FOR CHEAPER STEAM

Economical generation of steam can be secured only by the correct application of metering, controlling, and regulating equipment. Bailey engineers will gladly help you obtain the most suitable selection for your boiler plant. Write for literature on any of these widely known Bailey products.

Boiler Meters
Multi-Pointer Gages
Combustion Control
Feed Water Control
Fluid Meters
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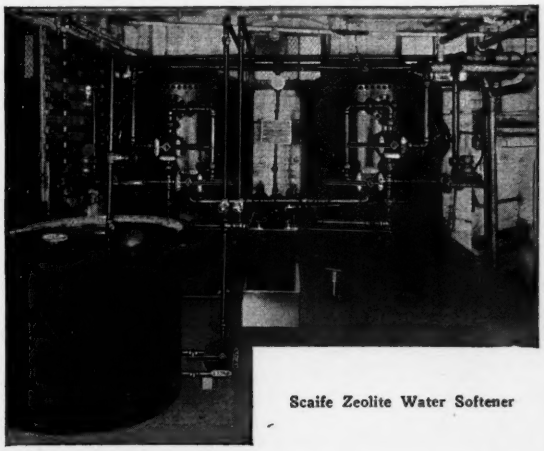
BAILEY METER CO.
1040 Ivanhoe Rd., Cleveland, O.

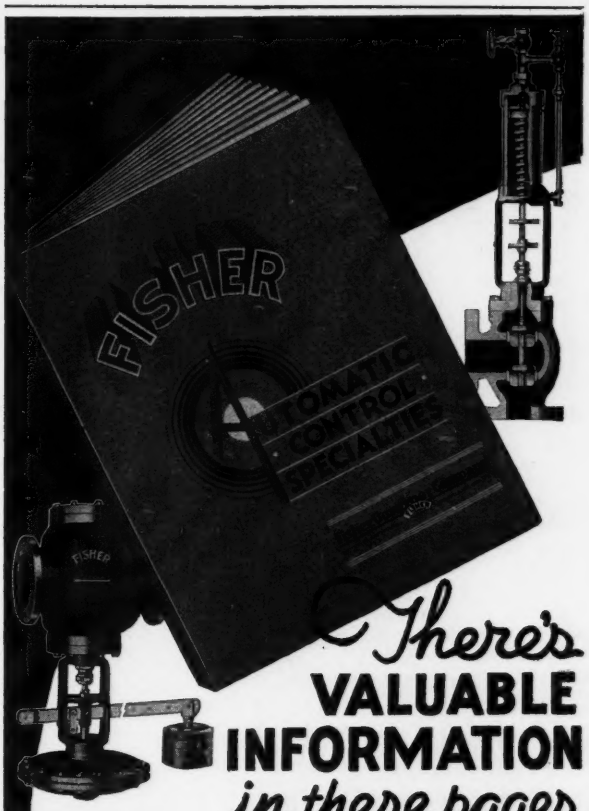
Water Softeners and Filters for every Industrial and Domestic Use



Scaife Zeolite Water Softener

Cold Process: Intermittent, Continuous and Zeolite. Hot Process, Semi-Hot Process and specially designed Water Softeners.
Gravity, Pressure and Oil Removal Filters.
Write for Information and Bulletins.

WM. B. SCAIFE & SONS CO.
OAKMONT, PA.
NEW YORK PITTSBURGH CHICAGO



There's VALUABLE INFORMATION in these pages

SEND FOR THIS CATALOG

Valuable information that will save you time and money in the selection of pump governors, reducing valves, float valves, and similar devices.

This FISHER Catalog is as new as the "New Deal", and has many new and different automatic control specialties illustrated and fully described.

No catalog file is complete without it.

Since 1881 FISHER has maintained leadership in the development of automatic controls. FISHER again steps forward by issuing the only complete new catalog in the automatic specialty industry during the year 1933.

We urge every executive and engineer interested in affecting plant economy to fill in and mail us the coupon below.

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FISHER TRADE MARK
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FISHER GOVERNOR CO. 418 S. First Ave., Marshalltown Ia.
Gentlemen: Without obligation please send the new Fisher Catalog.
Firm Name
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City
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ANNOUNCING

new instruments from Taylor

RECORDERS AND RECORDING REGULATORS

With new, modern case design with improved mechanism

New in beauty . . . improved in accuracy and durability—the new Taylor Recording Thermometer. The same case and outward appearance obtain for the new Taylor Recording Pressure Gauge.

New Taylor Recorders of Temperature and Pressure

THESE new temperature and pressure recorders have now replaced all Taylor instruments previously listed for industrial use where accurate, hour-by-hour temperature or pressure records are essential.

The first feature is the new die-cast rectangular case, the creation of an eminent modern American commercial designer. The clean-cut, simple lines give a distinctive and stimulating new beauty to this type of instrument. Modern art appears on the instrument panel board.

The case comes in black enamel finish. It is dust-proof, moisture-proof, and rust-proof.

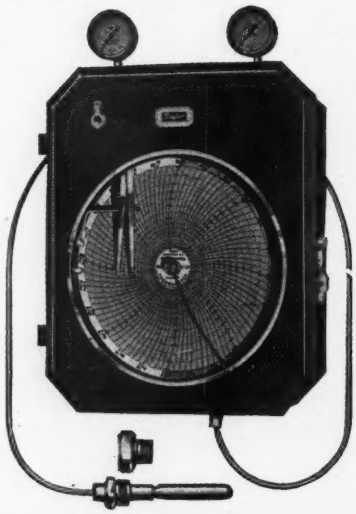
The inner mechanism is improved and refined so that it sets even higher standards of durability and accuracy in recorder performance. Here are outstanding features:

1. Improved mechanism with much lighter movement. Small non-corrosive bearings and pivots reduce frictional forces and vibration materially. Result—more accurate performance.

2. Longer and more flexible pen-arm made of stainless steel (16-8). This gives better chart records due to less pen friction.

3. Micrometer adjustment of precision accuracy is provided for setting the pen-arm. Minor adjustments are made easier.

These new temperature and pressure recorders are available as mercury-, vapor- or gas-actuated instruments.



Beauty, style, protection for inner mechanism—you get all three in this new Taylor Recording Regulator. Like the new Taylor Recording Thermometer, this instrument is a general purpose regulator for use in any industry.

New Taylor Recording Regulators for Temperature and Pressure

The new Taylor Recording Regulators have the same die-cast cases with the simple, dignified lines and the same features that make the new Taylor Recorders distinctive in style and beauty. The following features are especially important:

1. A new method for balancing instrument performance to time lag in apparatus. The result is optimum control for a given set of operating conditions.

2. Reversal of the regulator action is quickly and easily accomplished without any extra parts.

3. Provision for micrometer adjustment in setting control point. When manually changing the control point, small increments of set pointer movement can be made easily.

4. Incorporation of air pressure compensator. This contributes to accurate control when air supply pressure varies.

All three of the features mentioned above under the new Recorders are also to be found in the new Taylor Recording Regulators.

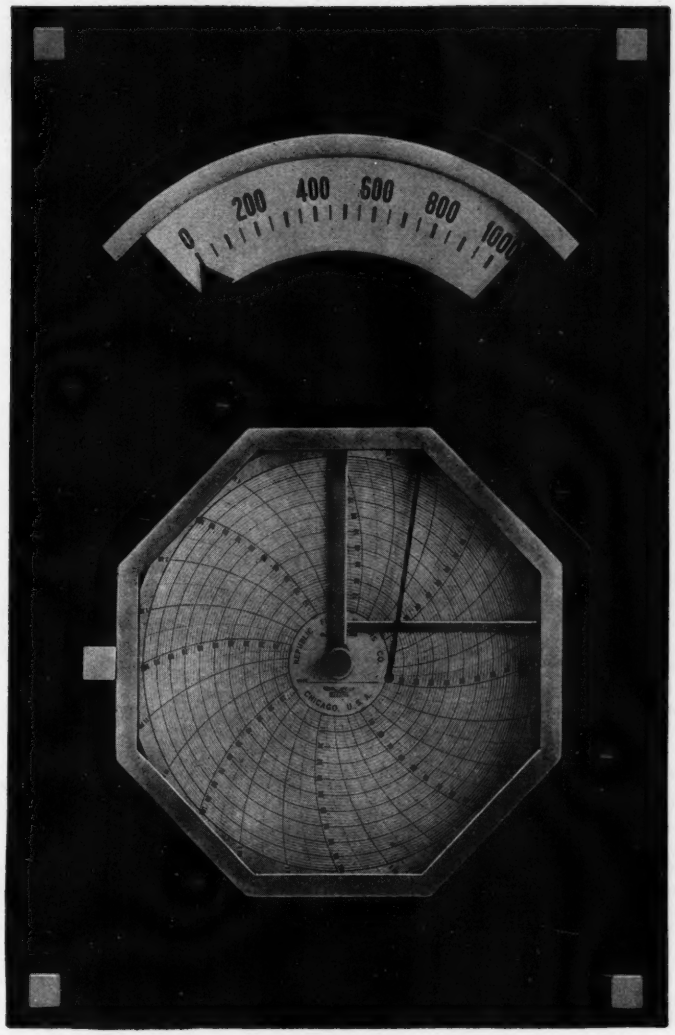
For any other information regarding these new Taylor Instruments and their use in your particular plant, get in touch with a Taylor Representative. Or write Taylor Instrument Companies, Rochester, N. Y.

† Tycos **Taylor**

Indicating / Recording • Controlling

TEMPERATURE *and* PRESSURE INSTRUMENTS

† The name Taylor now identifies our complete line of products including Tycos instruments.



JUST OUT—BULLETIN NO. 900 DESCRIBING THE NEW REPUBLIC REMOTE READING LIQUID LEVEL AND PRESSURE INDICATORS AND RECORDERS. WRITE FOR YOUR COPY TODAY.

REPUBLIC FLOW METERS CO.

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STEAM ENGINE

● Moisture in steam interferes with cylinder lubrication in two ways. It tends to wash off the lubricating film supplied by the oil and the surface which it has already moistened is difficult to cover with an oil film. Wet steam conditions require an oil that will properly emulsify with water. Such an oil must readily replace any water present on the surfaces and after having built up an oil film it must resist being removed by the water.

Since the water always present under wet steam conditions constitutes the largest single factor adversely affecting the lubrication of steam cylinders, anything which can be done to reduce the quantity of the moisture contained in the steam will be of assistance in securing better lubrication. The installation of an efficient separator just ahead of the throttle will greatly assist in preventing excess moisture, and impurities from the boiler, gaining access to the engine cylinder. A mistake is often made by not installing a separator of sufficient size to properly remove the moisture. While any separator will be of appreciable assistance, one of proper size will give much more efficient results. The separator should be drained through a trap and where the steam contains appreciable impurities, frequent inspections and cleanings are necessary to prevent improper operation due to deposits.

Moisture in the steam at the throttle may come from two sources. Condensation of steam in the steam line is the first of these. Long steam lines cause greater condensation of steam than short lines; also non-insulated or poorly insulated lines cause excessive steam condensation. These must be avoided wherever possible. Steam lines which are too large in capacity will promote condensation since the velocity of the steam through the line will be so low that time is permitted for excessive condensation to take place. Long lines should be equipped with traps at suitable points to drain the water and prevent it reaching the cylinder.

Another source of water in steam is priming and foaming of the boiler. The combined concentration of dissolved solids and suspended solids that appear in feed water is the biggest cause of boiler foaming. These consist mainly of chlorides, phosphates and sulphates of calcium, magnesium and sodium. All are soluble in cold water, but many of them are only slightly soluble at boiler temperatures. When they are present in sufficient concentrations to cause foaming or priming appreciable quantities are entrained with the steam and carried into the engine cylinder. Much of this material is abrasive and contributes greatly to serious erosion and sticking of parts which ultimately may result in the costly expense of cylinder reboring and replacement of valves and piston rings. Priming and foaming of boilers usually can be reduced by more frequent blowing down of the boiler and improving the condition of the feed water. Suitable dry pipes also may be of assistance in reducing or preventing foaming. It should be eliminated, if possible, not only because of the detrimental effect on lubrication of the water it causes in the steam, but also because of the serious results of the dirt and abrasive material carried into the cylinder under such conditions.

In the operation of reciprocating steam pumps appreciable water often is encountered in the cylinders even though the quality of the steam leaving the boilers is good. Where the pump operation is intermittent or very slow, the steam condenses in the line near the pump and when the valve is opened slugs of water enter the cylinder. The resultant washing effect is very severe and a cylinder oil with unusual ability to resist the washing action of water is required under such circumstances.

In addition to having the ability to replace any water present on the surfaces to be lubricated and resist removal by water, the oil must also atomize quickly and completely. The temperature of wet steam is lower than that of dry steam and superheated steam. This has less thinning effect on the oil, consequently, oils for wet steam should be lighter bodied than those for dry and superheated steam to assist in atomization of the oil.

The oil should be introduced into the steam line five or six feet ahead of the throttle unless limited to a shorter distance by the position of the separator. To obtain the full effect of the velocity of the steam and prevent the oil from dribbling down the inside of the steam pipe, the oil line should extend to the center of the steam pipe. A tip, for the oil feed line, consisting of a straight 3/8" pipe cut off square at the end is a very practical aid in atomization as it functions well as an atomizer and does not readily clog up from deposits.

The nature of the oil should be such as to give a uniform film of oil over valves, pistons, rings and cylinders. Only an oil which gives a uniform film can be fed in small enough quantities to provide economical oil consumption. Any other must be fed in excessive quantities causing pools of oil to collect in counterbores, etc., tending to increase cylinder deposits. Excessive feed of oil for any cause is detrimental where the steam is used for process work or the condensate is used for boiler feed water.

The oil itself must be properly refined and carefully manufactured so it will have no tendency to form gummy or carbonaceous deposits in the cylinders or on the valves and rings.

In conclusion it is seen that to be a completely satisfactory steam cylinder oil for use under wet steam conditions, the oil used must possess all of the following characteristics:

1. Atomize quickly and completely.
2. Give complete and uniform coverage of valves and cylinders.
3. Replace any water present and resist removal by water.
4. Give maximum freedom from carbon or gummy deposits.

Of the above four characteristics, the ability of the oil to replace any water present and resist removal by water is by far the most important characteristic for use under wet steam conditions.

NRA MEMBER U.S. WE DO OUR PART

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(Indiana)
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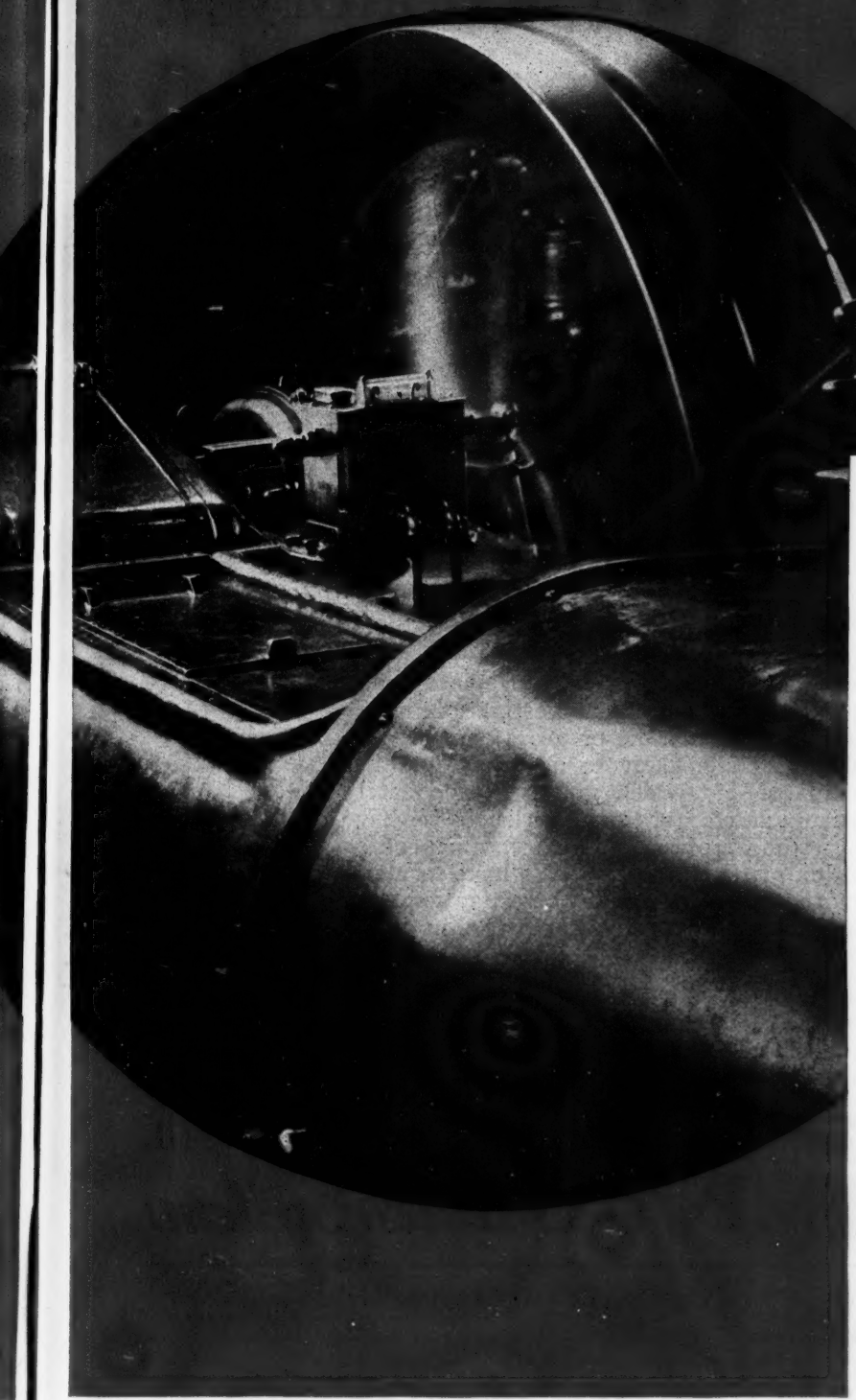
LUBRICATION



STANDARD OIL COMPANY (INDIANA) SERVICE

A NEW TYPE OF CYLINDER OILS

StanoCyl Oils are a new development in steam cylinder oils. They are radically different from the conventional types of cylinder oils, and have characteristics never before combined in one oil.

They atomize quickly and completely.

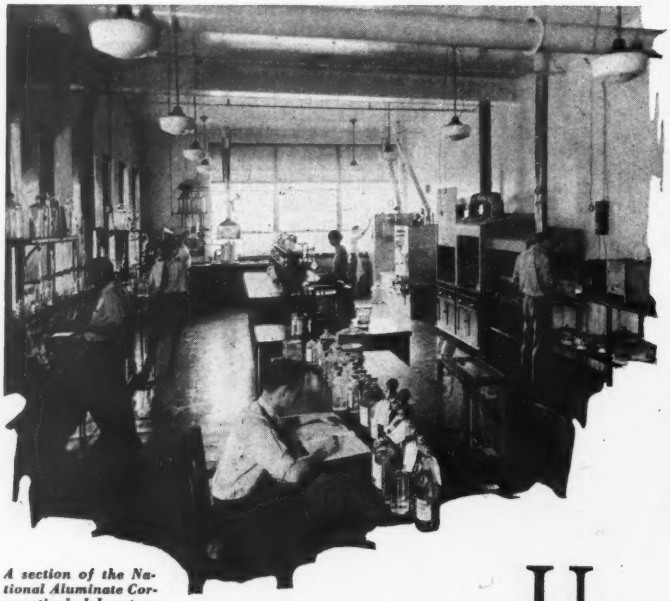
They give complete and uniform coverage of the valves and cylinders.

They have the ability to replace any water present and to resist removal by water.

They give maximum freedom from carbon or gummy deposits.

The three grades of StanoCyl meet any conditions encountered in present day practice. Usually StanoCyl "SH" is recommended for extremely severe conditions. StanoCyl "D" is advised for all average conditions. For particularly wet conditions, StanoCyl "W" is best. It will be found especially effective for Corliss engines where difficulty has been experienced due to wet steam conditions.

Why not investigate StanoCyl oils?



A section of the National Aluminate Corporation's laboratory at the Clearing (Chicago) Plant.

Make this YOUR Laboratory for research in water treatment

USERS of the Nalco System enjoy the full advantage of complete research facilities and a staff of leading specialists in water treatment.

We have spared no pains or expense in providing the best possible research work in water treatment problems. Without such work the Nalco standard of service would be impossible. But the problems we work on are your problems—either directly or indirectly. You get the benefit, just as though you owned the laboratory and paid the staff salaries.

Money saving recommendations in your plant today may be based on laboratory or plant investigations made by our research department months or years ago. If you have water trouble which is likely to be found in other plants similarly situated, but which cannot be adequately met out of our accumulated store of experience, we have unsurpassed facilities and professional ability which can be devoted to a solution of that problem. We have in many instances spent more money on such an investigation than we received from the customer for chemicals in many months.

If you are not familiar with the possibilities of "your" laboratory and "your" research staff, use the coupon below to ask for the first service—a FREE survey of your water conditions.

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National Aluminate Corporation, 6224 W. 66th Place, Chicago, Ill.

SODIUM ALUMINATE *(Nalco System)*

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☐ Send me your free booklet, "Standardized Feedwater Treatment."

☐ Have an engineer make a feedwater survey of my plant. This does not obligate me in any way.

☐ Give me the names of nearby NALCO users or companies with plants similar to mine.

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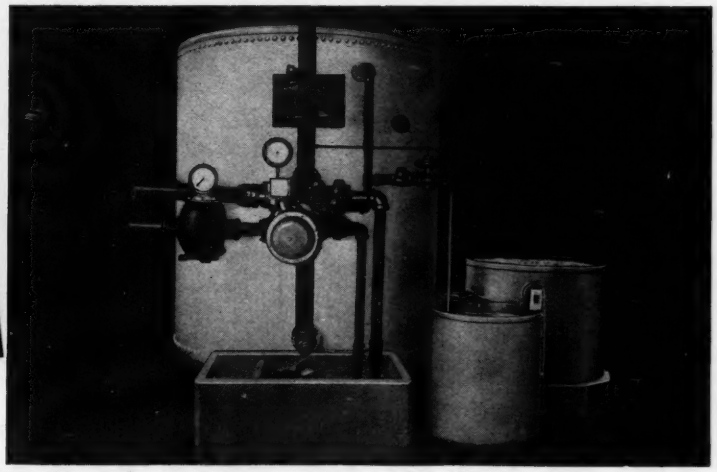
Never cost so little . . . Saved so much!

Permutit's new fully automatic water softener substantially reduces operating costs.



TODAY you can have scale-free boiler feed water under permanent electric control. For elimination of human error through Permutit's development of precise electrical regeneration produces soft water at lower cost than ever before.

Here is a direct method of cutting operating costs. If your plant does not have water treating equipment, this new method offers you a probable saving of thousands of dollars a year. But if you have a zeolite water softener, as over 9000 other power plants now have, Permutit's new automatic control can be applied to your present equipment and will produce soft water at a lower cost per thousand gallons. Read the seven points at the right.

SAVE with Soft Water

It Never Forgets

Water treatment is a sure and proven way to cut power costs. *Automatic* water treatment is still a further money saver.

Write for descriptive folder that tells you how this automatic control operates.

7 POINTS OF SUPERIORITY

1. **Most efficient zeolite water softener ever built.**
2. **All operations automatically carried out under precise control.**
3. **Completely softened water—no overrunning, no under-regeneration.**
4. **Thorough washing and rinsing with minimum quantity of water assure clean, active zeolite.**
5. **Saves salt—uses only the absolute minimum required.**
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7. **Automatic features can be applied to any existing downflow zeolite water softener.**

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330 W. 42nd Street, New York

Please send me full particulars about your new Automatic Water Softener. This entails no obligation, of course.

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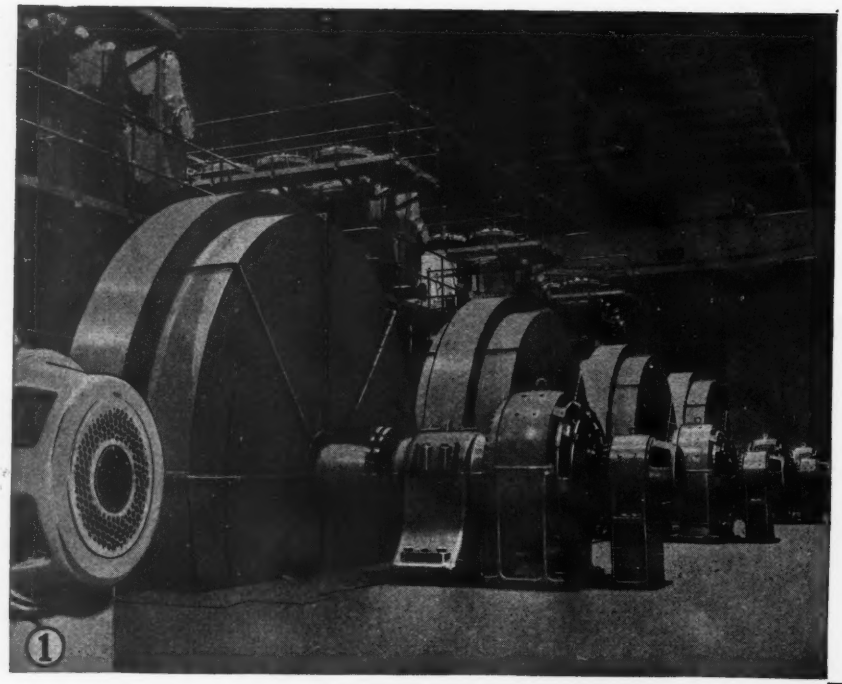

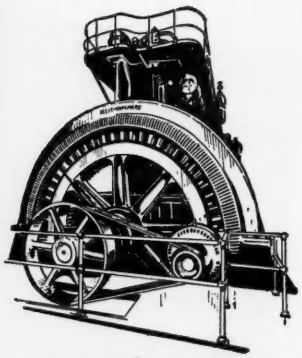

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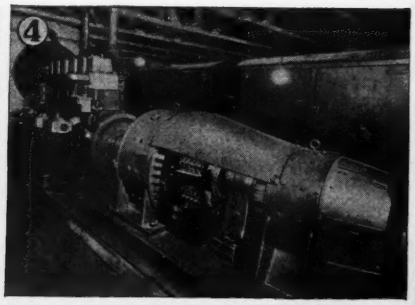
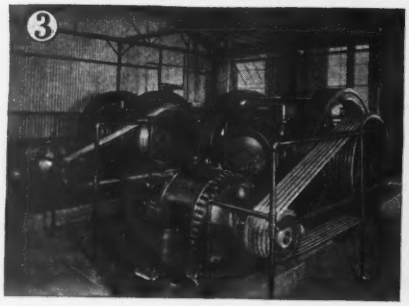
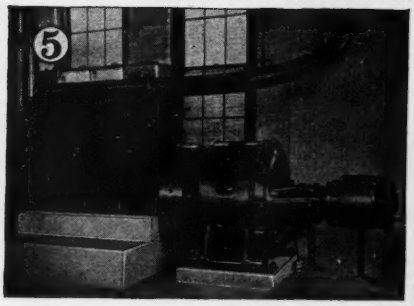
for Internal Combustion Engines ... All Types ... All Capacities







1. The Largest Diesel Engine Driven Generators in America. Five 7,500 kva, 50 cycle, 167 rpm Allis-Chalmers Generators with main and pilot exciters on Hamilton Diesel Engines, City of Vernon, California.

2. The Largest Gas Engine Driven Generators in the World (in the foreground) rated 5000 kw, each. More than 155,000 kva. in 47 Allis-Chalmers gas engine-generator units now installed in the Chicago area.

3. Small Generators driven by gas engines through Texrope Drive.

4. Internal Combustion Engine Generator unit for rotary oil well drilling and pumping.

5. Generator direct-connected to a Diesel engine.

Information furnished on request.

ALLIS-CHALMERS

Allis-Chalmers Manufacturing Company, Milwaukee

NO SEAT TO LEAK

STANDARD WITH LEADING BOILER MANUFACTURERS

OVER 10,000 YARWAY USERS

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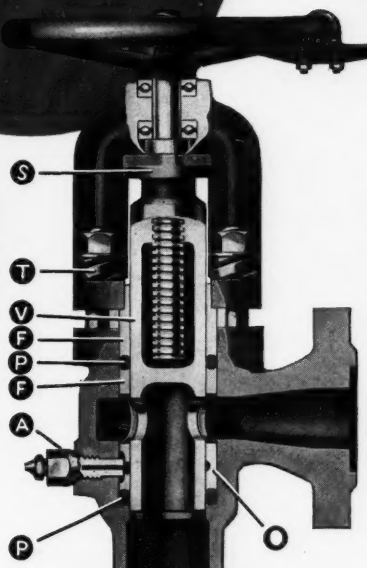
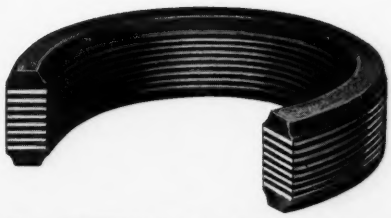
SELECTED FOR FEDERAL, STATE AND MUNICIPAL INSTITUTIONS



OPERATION: After valve is closed, shoulder S on plunger V contacts with upper follower gland F, forcing it down into body and compressing packing P above and below port. Annular groove O connects with Alemite fitting A for lubricating plunger and packing. Yoke springs T maintain continuous pressure through follower glands F on packing rings P.



New YARWAY Laminated Packing guaranteed for two years if used according to operating instructions. This packing, a development of the Yarway High Pressure Steam Laboratory, consists of several stainless steel rings with long fibre asbestos between, compressed and heat treated for high pressures and temperatures and with a life six times as great as packings previously used.

YARWAY SEATLESS

Made of gray iron, electric furnace and forged steel for all pressures to 2000 lbs. Send for Booklet B-417.

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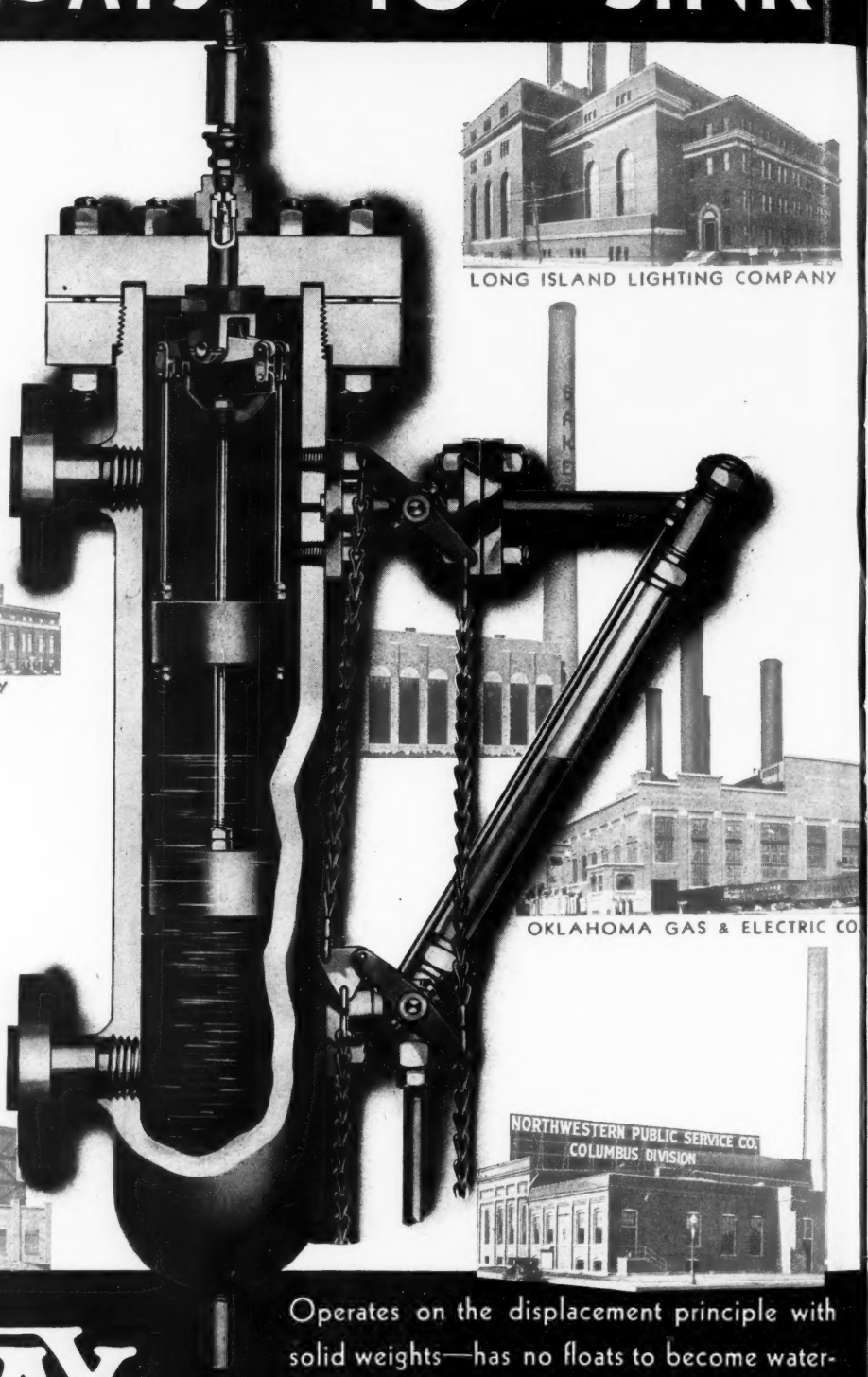

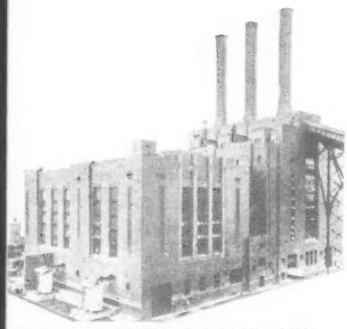

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FLOATLESS HI-LO ALARM
WATER COLUMN AND
SE-SURE INCLINED WATER GAGE

Operates on the displacement principle with solid weights—has no floats to become water-logged and useless.

Inclined gage glass for easy reading of water levels, gives unobstructed view from any angle.

Made of gray iron and forged steel in types for low and high pressures.

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YARNALL-WARING COMPANY, MERMAID STREET, PHILADELPHIA

It cost $42 to repair this block insulation job. *It would have cost less than $10 if the insulating material had been EAGLE "66" Insulating Cement* ● The photograph above shows a large hot water storage tank, that has been insulated with Block insulation. One end of this tank leaked, resulting in considerable damage to the insulation, and the necessity of removing the insulation in order to make repairs.

The entire insulation on the end of the tank (approximately 100 square feet) was wrecked. To repair the block insulation after the tank was fixed, cost actually $42. If the tank had been insulated with Eagle "66" Insulating Cement, repairs to the insulation would have cost less than $10.

It isn't often that we happen to be on hand and catch a photograph of a job like this. We offer it as a case in point, to prove by contrast one of the advantages of good plastic insulation made with Eagle "66".

We make all kinds of heat insulation — including pipe covering, blanket insulation, blocks, insulating cement, waterproofing cement, boiler setting cement, etc.

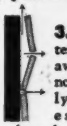
SEND THE COUPON — if you would like a free sample of Eagle "66" and book describing its new principle of "springy ball" construction.

ADVANTAGES OF PLASTIC AS AGAINST BLOCK INSULATION —WHEN EAGLE "66" INSULATING CEMENT IS USED

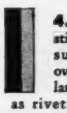
1. Plastic Insulation sticks to a hot surface, becoming an efficient, one-piece insulation—with no seams or joints to open up to escaping heat. Blocks often pull away—shrink and open up.
2. Eagle "66" Cement offers greater ease and economy of application. Can be applied often for one-half labor cost of Block, using your own workmen. This gives greater control over work, as well as economy. Cement goes on easier around corners and over irregular surfaces.
3. With Cement only one material is needed — and *no* special tools. With Blocks you need several accessories—including a finishing cement.
4. After it is applied, Eagle "66" is several times stronger than a section of Block.
5. Repairs, changes and alterations are much easier and less expensive with Eagle "66".
6. No loss from breakage with Eagle "66".
7. Eagle "66" is 100% reclaimable.
8. With all these advantages, Plastic (with Eagle "66") is no more expensive than Block.

1. With Blocks, seams and joints are liable to crack open, letting out heat.

2. Plastic forms a continuous, one-piece insulation.



3. Blocks tend to pull away—do not fit tightly. Heat escapes through openings.



4. Plastic sticks to hot surface—over irregularities such as riveting.

● The Eagle-Picher Lead Company, Dept. PE12, Cincinnati, Ohio
Please send me your free sample and booklet about Eagle "66" Insulating Cement.

*Name*_____

*Firm*_____

*Address*_____

EAGLE "66"

Insulating Cement — embodying the new principle of "springy ball" construction

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Standard Oil Co. (Indiana)
Texas Co.

Heat Exchangers
Superheater Co.
Vogt Machine Co., Henry

Hose
United States Rubber Co.

Hydrometers
Taylor Inst. Cos.

Ice Making & Refrigerating Machinery
Vogt Machine Co., Henry.

Injectors and Inspirators
Superheater Co.

Instruments, Electrical
General Elec. Co.

Insulating Cement
Eagle-Picher Lead Co.

Insulation, Heat
Eagle-Picher Lead Co.

Insulating Material
General Elec. Co.

Joints, Expansion
Yarnall-Waring Co.

Lubricants
Socony Vacuum Corp.
Standard Oil Co. (Indiana)
Texas Co.

Lubricators
Lunkenheimer Co.
Manzel Bros. Co.
Williams Valve Co., D. T.

Meters, Air and Gas
Bailey Meter Co.
Republic Flow Meters Co.

Meters, Boiler
Bailey Meter Co.
Brown Inst. Co., The.
Republic Flow Meters Co.

Meters, Coal
Bailey Meter Co.
Republic Flow Meters Co.

Meters, Water and Steam
Bailey Meter Co.
Brassert & Co., H. A.
Brown Inst. Co., The.
Republic Flow Meters Co.
Simplex Valve & Meter Co.

Meters, V-Notch
Yarnall-Waring Co.

Monel Metal Rings, Rods, Castings, Forgings, Tubings, Sheets, Wire and Wire Cloth
International Nickel Co.

Motors
Allis Chalmers Mfg. Co.
General Elec. Co.

Nozzles for All Purposes
Yarnall-Waring Co.

Oil and Grease Cups
Lonergan Co., J. E.
Lunkenheimer Co.
Williams Valve Co., D. T.

Oiling Systems
Burt Mfg. Co.

Oil Purifiers
De Laval Steam Turb. Co.

Oil Removing Filters
Scaife & Sons Co., Wm. B.

Oil Tanks
Manzel Bros. Co.

Oils, Lubricating
Socony Vacuum Corp.
Standard Oil Co. (Indiana)
Texas Co.

Packing, Piston and Rod, Valve Stem
United States Rubber Co.

Packing, Sheet
Jenkins Bros.
United States Rubber Co.

Pipe Coils
Vogt Machine Co., Inc.
Superheater Co.

Pipe Savers
Sarco Co., Inc.

Pulverized Fuel Equipment
Combustion Eng'r'g Co., Inc.
Foster Wheeler Corp.
Kennedy-Van Saun Mfg. & Engrg. Corp.

Pumps, Boiler Feed
Allis Chalmers Mfg. Co.
De Laval Steam Turb. Co.
Moore Steam Turb. Corp.
Viking Pump Co.

Pumps, Centrifugal
Allis Chalmers Mfg. Co.
De Laval Steam Turb. Co.
Moore Steam Turb. Corp.

Pumps, Elevator, Fire and General Service
De Laval Steam Turb. Co.
Viking Pump Co.

Pumps, Oil and Electric
Lonergan Co., J. E.
Manzel Bros. Co.
Viking Pump Co.

Pumps, Rotary
Viking Pump Co.

Pumps, Turbine
Moore Steam Turb. Corp.

Pumps, Waterworks
Moore Steam Turb. Corp.

Purifiers, Boiler Feed
Permutit Co.
Scaife & Sons Co., Wm. B.

Pyrometers
Brown Inst. Co.
Defender Auto. Reg. Co.
Republic Flow Meters Co.
Superheater Co.
Taylor Inst. Cos.

Recording Instruments
Simplex Valve & Meter Co.
Taylor Inst. Cos.

Refractories
Eagle-Picher Lead Co.

Regulators, Damper
Atlas Valve Co.
Brown Inst. Co., The.
Defender Auto. Reg. Co.

Regulator, Fan Engine
Atlas Valve Co.
Defender Auto. Reg. Co.

Regulators, Feed Water
Atlas Valve Co.
Bailey Meter Co.
Brassert & Co., H. A.
Chaplin-Fulton Mfg. Co.
Sarco Co., Inc.
Squires Co., C. E.
Swartwout Co.

Regulators, Pressure
Brassert & Co., H. A.
Chaplin-Fulton Mfg. Co.
Fisher Governor Co.
Sarco Co., Inc.
Squires Co., C. E.

Regulators, Temperature
Atlas Valve Co.
Brassert & Co., H. A.
Brown Inst. Co., The.
Sarco Co., Inc.
Taylor Inst. Cos.

Rust Preventives
Dearborn Chem. Co.

Scale Removers, Mechanical
Lagonda Mfg. Co.
Pierce Co., Wm. B.
Roto Co., The.

Scale Removing Compounds
Dearborn Chemical Co.

Separators and Extractors, Steam and Oil
Nicholson & Co., W. H.
Swartwout Co.
Williams Valve Co., D. T.

Sodium Aluminate
Dearborn Chemical Co.
National Aluminate Corp.

Sprocket Rims
Babbitt Steam Spec. Co.

Stacks, Metal
Vogt Machine Co., Henry

Steam Traps
Armstrong Mach. Wks.
Fisher Governor Co.
Nicholson & Co., W. H.
Sarco Co., Inc.
Squires Co., C. E.
Swartwout Co.
Williams Valve Co., D. T.

Stokers, Mechanical, Overfeed and Grate
American Engrg. Co.
Babcock & Wilcox Co.
Combustion Eng'r'g Co., Inc.
Detroit Stoker Co.
Johnston & Jennings Co.

Stokers, Underfeed
American Engrg. Co.
Combustion Eng'r'g Co., Inc.
Detroit Stoker Co.

Strainers
Brassert & Co., H. A.
Sarco Co., Inc.

Superheaters, Steam
Babcock & Wilcox Co.
Superheater Co.

Tachometers
Brown Instr. Co.

Tanks
Graver Tank & Mfg. Corp.
Scaife & Sons Co., Wm. B.
Vogt Machine Co., Henry

Thermometers, Dial
Sarco Co., Inc.

Thermometers, Recording and Indicating
Brown Inst. Co., The.
Defender Auto. Reg. Co.
Sarco Co., Inc.
Taylor Inst. Cos.

Traps, Compressed Air, Vacuum
Armstrong Machine Wks.
Nicholson & Co., W. H.

Traps, Steam, Radiator and Return
Armstrong Machine Wks.
Nicholson & Co., W. H.
Sarco Co., Inc.

Tube Cleaners, Boiler and Condenser
Liberty Mfg. Co.
Pierce Co., Wm. B.
Roto Co., The

Turbine, Hydraulic
Allis Chalmers Mfg. Co.
De Laval Steam Turb. Co.

Turbines, Steam
Allis Chalmers Mfg. Co.
De Laval Steam Turb. Co.
Elliott Co.
General Elec. Co.
Moore Steam Turb. Corp.
Terry Steam Turbine Co.

Unions
Atlas Valve Co.
Dart Mfg. Co., E. M.
Edward Valve & Mfg. Co., Inc.

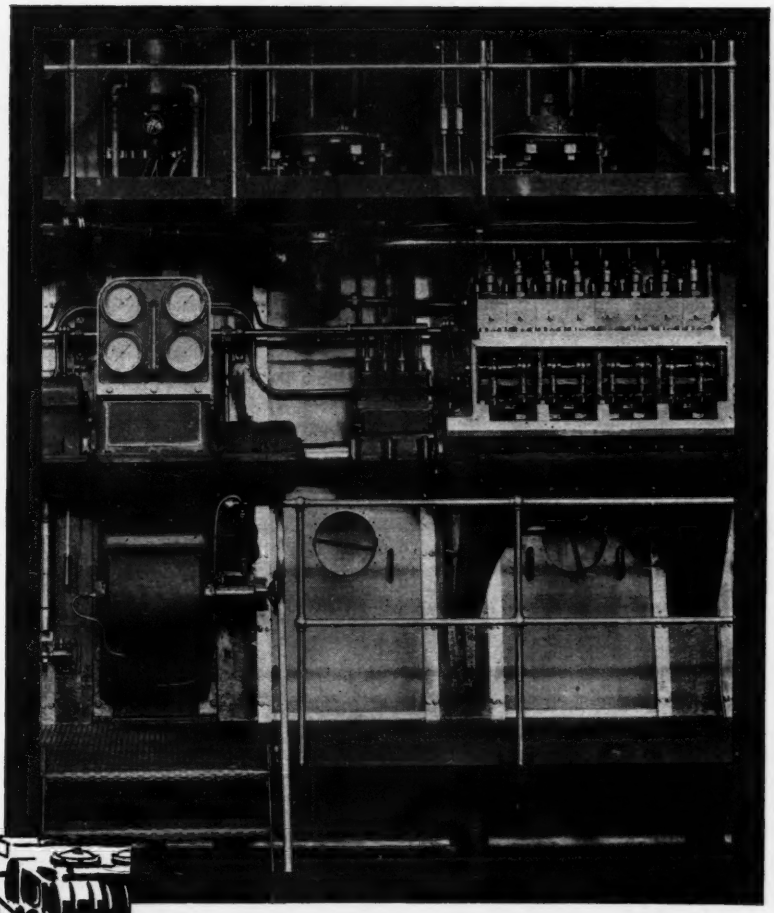
Valve Discs
Jenkins Bros.
United States Rubber Co.

Valves, Auto. Cut-Off
Edward Valve & Mfg. Co., Inc.
Fisher Governor Co.

TEXACO URSA OIL

chosen for the country's greatest

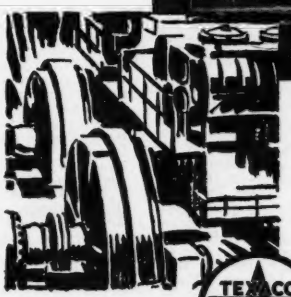
Diesels . . .



TEXACO URSA OIL lubricates the cylinders of the 35,000 h.p. Diesel plant of Vernon, California. These are the largest Diesel engines ever built in America. Naturally, the lubricant to be used for the cylinders was one of the important questions for the Chief Engineer and engine manufacturers to decide.

These men had confidence in Texaco and they chose TEXACO URSA OIL for this major service. Performance has been excellent.

In this great plant, as in hundreds of others, TEXACO URSA OIL is making exceptional records for lubricating effectiveness, freedom from carbon and resistance to extremes of temperature and pressure. It is a remarkable oil for heavy-duty Diesel engine lubrication.



Try it. TEXACO URSA OIL is made in a viscosity grade for every type of engine. Texaco engineers stand ready to help you with any problem of Diesel lubrication. Write The Texas Company.

THE TEXAS COMPANY 135 EAST 42ND STREET, NEW YORK CITY

TEXACO LUBRICANTS

Valves, Blow-Off
Edward Valve & Mfg. Co., Inc.
Jenkins Bros.
Lunkenheimer Co.
Yarnall-Waring Co.

Valves, Check
Edward Valve & Mfg. Co., Inc.
Jenkins Bros.
Kennedy Valve Mfg. Co.
Williams Valve Co., D. T.

Valves, Float
Atlas Valve Co.
Fisher Governor Co.

Valves, Foot Operated
Nicholson & Co., W. H.

Valves, Gate and Globe
Edward Valve & Mfg. Co. Inc.
Jenkins Bros.
Kennedy Valve Mfg. Co.
Lunkenheimer Co.
Vogt Machine Co., Henry
Williams Valve Co., D. T.

Valves, Hydraulic
Kennedy Valve Mfg. Co.

Valves, Pop Safety
Lonergan Co., J. E.
Lunkenheimer Co.
Vogt Mach. Co., Henry

Valves, Pump
Fisher Governor Co.
Jenkins Bros.
United States Rubber Co.

Valves, Radiator
Jenkins Bros.
Kennedy Valve Mfg. Co.
Williams Valve Co. D. T.

Valves, Reducing, Regulating and Relief
Atlas Valve Co.
Chaplin-Fulton Mfg. Co.
Edward Valve & Mfg. Co., Inc.
Fisher Governor Co.
Lonergan Co., J. E.
Squires Co., C. E.
Swartwout Co.

Valves, Solenoid Operated
Nicholson & Co., W. H.

Valves, Steel
Edward Valve & Mfg. Co., Inc.
Kennedy Valve Mfg. Co.

Valves, Three and Four Way
Nicholson & Co., W. H.

Ventilating Apparatus
Burt Mfg. Co.
Swartwout Co.

Waste Heat Recovery Systems
Babcock & Wilcox Co.
Edge Moor Iron Co.

Water Columns and Alarms
Lunkenheimer Co.

Water Cooling Equipment
Yarnall-Waring Co.

Water Purifying and Softening Systems
Dearborn Chemical Co.
National Aluminate Corp.
Permutit Co.
Scaife & Sons Co., Wm. B.

Water Screens
Combustion Eng'r'g Co.

Water Testing Equipment
Dearborn Chem. Co.
National Aluminate Corp.

Water Walls
Edge Moor Iron Co.
Combustion Eng'r'g Co.
Superheater Co.

Whistles
Lonergan Co., J. E.
Lunkenheimer Co.

SIGNBOARD SECTION
Quick Action Opportunities

RATES FOR ADVERTISING IN THE SIGNBOARD SECTION

CLASSIFIED RATES

Advertisements published in the Signboard Section which come under the classifications of "Positions Wanted"—"Engineers Wanted"—"Salesmen & Agencies"—"Patent Attorneys"—etc., are charged for by the line.

The rate per line for one insertion is—50c

The minimum advertisement accepted is four lines. Classified advertisements are all printed in the same style and sizes of type. No display type is used. Box numbers can be used. Replies are forwarded promptly.

DISPLAY RATES

The unit of space used for advertisements under the headings of "Equipment Wanted"—"Equipment for Sale"—"Technical Books"—"Professional Cards"—etc., is the column-inch which is one column (2¼ in.) wide and one inch deep. The basis rate is $5.50 for one column-inch in one issue. This basis rate decreases as larger space or more than one issue is used.

Quotations will be sent promptly on request for any desired size of space or number of insertions.

Display headings, bold-face or italic type and signature cuts are permissible in Display Advertisements.

EQUIPMENT FOR SALE

SPECIALS

1250 KVA. G. E. Alternator,—Hamilton Uniflow Engine, with Condenser. F.o.b. New York.....$8500

7500 KVA. Allis Chalmers Turbine, 250 lb. pressure, with Surface Condenser. F.o.b. New York.

281 KVA. G. E. Alternator—Nordberg Oil Engine. F.o.b. Georgia.....$4000

90 KVA. Wghse.-St. Marys Oil Engine. F.o.b. Alabama.....$2500

180 KVA. G. E.-Chuse Uniflow Engine. F.o.b. Alabama.....$3000

DIRECT CURRENT UNITS

200 KW. Wghse. 250/125 volt Turbine, 0-15 lbs. back pressure. F.o.b. New York $2000

150 KW. G. E. 125 volt, Harrisburg Uniflow Engine. F.o.b. New York..$2500

Power Plant Equipment Co , Inc.
39-41 Cortlandt St., New York, N. Y.

WANTED TO BUY

WANTED TO BUY

Direct connected engine-generator set or turbo-generator in first class condition, from 250 to 275 kw., 220 volt, A.C., 3 phase, 60 cycle.

Reply to Box 1186

Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

It is very possible that a small advertisement, filling a space like this, would be sufficient to place your story before the progressive men who read this magazine. The cost is moderate—one reply might easily justify the expense. For prices on this or other sizes of advertisements write to Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

SALESMEN AND AGENCIES

REFRACTORY SALESMEN. An opportunity is open to a few men who have had experience in selling refractories to power plants and are willing to do hard consistent work. This is an old established company making a well-known and complete line of refractory materials. If you can qualify, write to Box 1183, c/o Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

POSITIONS WANTED

MANAGER of power plant, experienced in design and plant construction, power generation, electric systems, system operation, utility economics and organization. 12 years' experience with large utility companies. Please reply to Box 1185, c/o Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

POSITION WANTED as Chief Engineer or Plant Supt. of Municipal Diesel and Steam Generating plant. Is an electrical graduate with 16 years' experience in operation and in charge of plants and all auxiliaries; including eight years' experience with Diesel engines. Can furnish excellent references. At present employed as Chief Engineer and Plant Foreman of a 2000-kw. plant. Age 44. Married. Steady, sober and industrious. Held Montana 1st Class license for 10 years. Please reply to Box 1184, c/o Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

GRADUATE Mechanical Engineer, 38, available for engineering or executive position. For past eight years Works Manager large Eastern company manufacturing power plant equipment. Excellent references. Please write to Box 1181, c/o Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

ELECTRICAL ENGINEER. Seven years' experience. Power plant operation, power distribution, industrial engineering, electrical design. Box No. 1182, c/o Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

POSITIONS WANTED

ELECTRICAL ENGINEER. Graduate of engineering college, B.S.E.E. degree. 12 years experience includes supervision of the construction and maintenance of both electrical and steam equipment in large industrial plants which sell power as a by-product and also in medium sized industrial plants. Was employed in several plants of one company for nine years and resigned for the purpose of acquiring further electrical education. Has also had some sales experience. A serious student of electrical engineering problems and practices. Desires a position in which he can prove his knowledge and ability. Age 33. Married. Able and willing to go anywhere. Please write to Box 1177, c/o Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

FIRST CLASS LICENSED ENGINEER. Ten years experience in large hotels and manufacturing plants. Complete knowledge of the operation and maintenance of electric generating equipment, elevators, pumps, water softeners, refrigeration machinery, boilers, heating and ventilating equipment and power plant instruments and accessories. Also some marine experience. 35 years of age and married. Can go anywhere. Holds N. J. Gold Seal License. If you can use an engineer who is old enough to be seasoned and young enough to be thoroughly up-to-date and ambitious, please write to Box 1178, c/o Power Plant Engineering, 53 W. Jackson Blvd., Chicago.

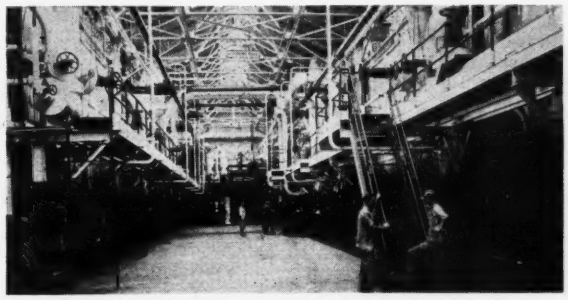
POSITION WANTED as electrical construction or designing engineer. Experienced in overhead line construction and overhead line engineering—also in the design of both city and rural lines. Good references. Age 30. University graduate with degree in electrical engineering. Will go anywhere. Please write to Box 1179, c/o Power Plant Engineering, 53 W. Jackson Blvd., Chicago.

ELECTRICAL ENGINEER. Graduate of Texas A. & M. College. Varied mechanical and electrical experience with power plants and railways; both shop and drafting room. Prefers employment with electric railroad or power plant, but will accept work with steam railroad or any other kind of electrical work. Will accept any job to start. Available immediately. Location immaterial. Address Box 1162 c/o Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

DEARBORN SEALING COMPOUND

Stops Infiltration - Clean - Permanent

Clean, well-cared-for boiler settings add much to the good appearance of a plant. It has been a great satisfaction to engineers to find that one application of Dearborn Sealing Compound makes a permanent coating which requires no future attention to keep it sightly and efficient.



The characteristics that make Dearborn Sealing Compound an ideal coating for boiler settings, for sealing concrete and in repairing roofs are: It penetrates and keys to porous material. Dries in a shiny-black surface which does not catch dirt and can be left black or painted with aluminum, bronze or cold water paints, if desired. It applies quickly and easily. In "setting", Dearborn Sealing Compound becomes a tough, non-hardening covering without pores. It cannot crack, check or become brittle. Is odorless and non-inflammable.

While the essential service of Dearborn Sealing Compound is to stop air infiltration, which it does perfectly, the permanence and excellent appearance make it increasingly welcome to engineers.

This is another product of Dearborn Laboratories, developed in our research for improved materials. If you do not yet know Dearborn Sealing Compound, an inquiry will give us opportunity to introduce it to you. Address us 310 South Michigan Avenue, Chicago; 205 East 42nd Street, New York; 2454 Dundas Street, West, Toronto.

NRA MEMBER U.S. WE DO OUR PART

DEARBORN CHEMICAL COMPANY

ELECTRICITY
WHAT IT IS AND HOW IT ACTS

by Andrew W. Kramer

"An excellent series of articles on the nature of electricity. It is most readable by those who think they know what it is all about and by those who admit they don't know much about electricity. The illustrations are excellent and quite frequently are of the simple and graphic form that many serious writers seem afraid to use. We recommend the book highly."
Review in RADIO BROADCAST

In two volumes, 582 pages, 5½x8, 242 illustrations, $4 postpaid

This book tells in simple language all that is known about electricity today. It explains what it is, how it produces various effects we are familiar with, what magnetism is, how light waves and X-rays are produced, what radioactivity is. Yet it is not fanciful; it deals only with known and accepted theories, presenting them simply and straightforwardly so that those not mathematically minded can understand them. It is this unusual treatment of a scientific subject that has won the favor of both the technical engineer and the layman.

In Volume I the electron as the fundamental basis for electrical phenomena is considered almost entirely with respect to itself. Volume II deals with radiation phenomena—the part played by the electron on propagation of light, the radiation of heat and radio waves.

TECHNICAL PUBLISHING CO., 53 W. Jackson Blvd., Chicago, Ill.

Sparks from the Advertising Pages

Advertising's Important Role In The Recovery Program

Advertising is as old as business itself. Yet somehow it seems to be a characteristically American institution. It fits in with our way of living and our way of doing business. It is recognized as a flexible and economical force for disseminating business news. And it is playing a vital role in the present program of the Administration for bringing about a sounder, more stable business structure.

One of advertising's chief functions today is to help end the price-cutting, profit-wrecking practices of the last four years. We are being reminded that it is now time to think something besides price—that price-whittling only threatens quality of workmanship and quality of materials—that a cheapened product at a cheapened price is no bargain.

Alert manufacturers are now utilizing the power of advertising to turn proper emphasis on the efficiency and cost-reducing abilities of their products.

Under the new order of things the use of improved machinery and equipment is going to be an absolute necessity for many industries. With higher prices for materials, with higher wages and shorter hours, with prices for finished products limited through discouragement by the Administration of too rapid advances, the only possible way for many manufacturers to make a fair profit is through a reduction of costs.

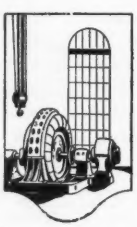
This reduction most generally can be effected through better methods, reinforced by the use of more efficient machinery and equipment. Many instances are known where the operation of obsolete equipment is adding to cost without helping employment. This is particularly true of service equipment of all kinds, such as power, heating, refrigerating, pumping and similar groups.

Replacing old units which can no longer deliver a satisfactory degree of service is a primary step in a program of cost-reduction. Instead of hindering employment its immediate effect would be to increase it, by giving manufacturers, distributors and others in the equipment industries more work to do.

Equipment prices, like those of other commodities, are certain to rise during the coming months. Now is a good time from the standpoint of the wise buyer to place orders for boilers, stokers, engines, pumps, piping and other equipment tied in with the power or heating services of industrial plants and central stations.

You will find the advertising messages in POWER PLANT ENGINEERING helpful in keeping informed on the improvements, cost-reducing abilities and other advantages of modern power equipment. They point the way to better operating methods and stronger profits.

THE BYSTANDER



GRAVER

GRAVER Filters in Executive Mansion, Albany, New York, used in swimming pool clarification.

Steel Fabrication

The GRAVER Organization has unexcelled facilities for manufacturing and fabricating tanks and steel plate up to 2 in., thick, nickel clad steel, stainless steel, aluminum and other special alloys. Our engineering department will cooperate with you in any degree desired, designing equipment completely to your needs or building it exactly to your specifications and specializing in welded construction. GRAVER'S production costs are low. Our field erection is recognized for its good workmanship. Our experience and responsibility are long standing. In addition to tanks and steel plate, GRAVER makes a complete line of oil industry and water conditioning equipment, also elevated tower tanks and B. F. Goodrich Vulcalock rubber lined steel tanks.

GRAVER TANK & MFG. CORP.

General Sales Offices: 332 South Michigan Avenue, Chicago. *General Office and Factory:* East Chicago, Indiana.

Eastern Factory: Catasauqua, Pa.

Nearly 75 Years in Steel Plate Fabrication

A Simple Statement about a Simple Principle

To our knowledge . . . the Viking Rotary Pump employs the simplest principle of any pump on the market. It has "Just Two Moving Parts." There are no springs, no valves nor tricky mechanisms to stick, break or get out of order.

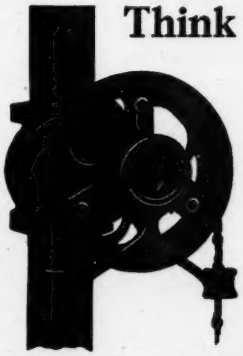
In the simplicity of its design rests the secret of Viking's success. Because of "Just Two Moving Parts" . . . it requires less power to operate . . . there is less friction and wear with a consequent longer life, that is free from repair and service expense. Pump buying is comparatively simple by deciding on the purchase of the extremely simple VIKING. Write today for FREE Folder and Prices.

VIKING PUMP COMPANY

Cedar Falls, Iowa

VIKING ROTARY PUMPS

Think of the TIME You'll Save



with Babbitt Sprocket Rims on all your "high-up" valves. No need of keeping a long, cumbersome ladder always on hand just to close a valve.

Babbitt Rims give you instant and positive control of overhead valves from the floor—save time, steam and accidents. Adjustable to any valve, easily attached and low in cost. Don't delay. Get your Babbitt Rims now! Complete information on request.

BABBITT STEAM SPECIALTY CO.

New Bedford, Mass., U. S. A.

Babbitt
—Adjustable—
SPROCKET RIM
with Chain Guide

KENNEDY

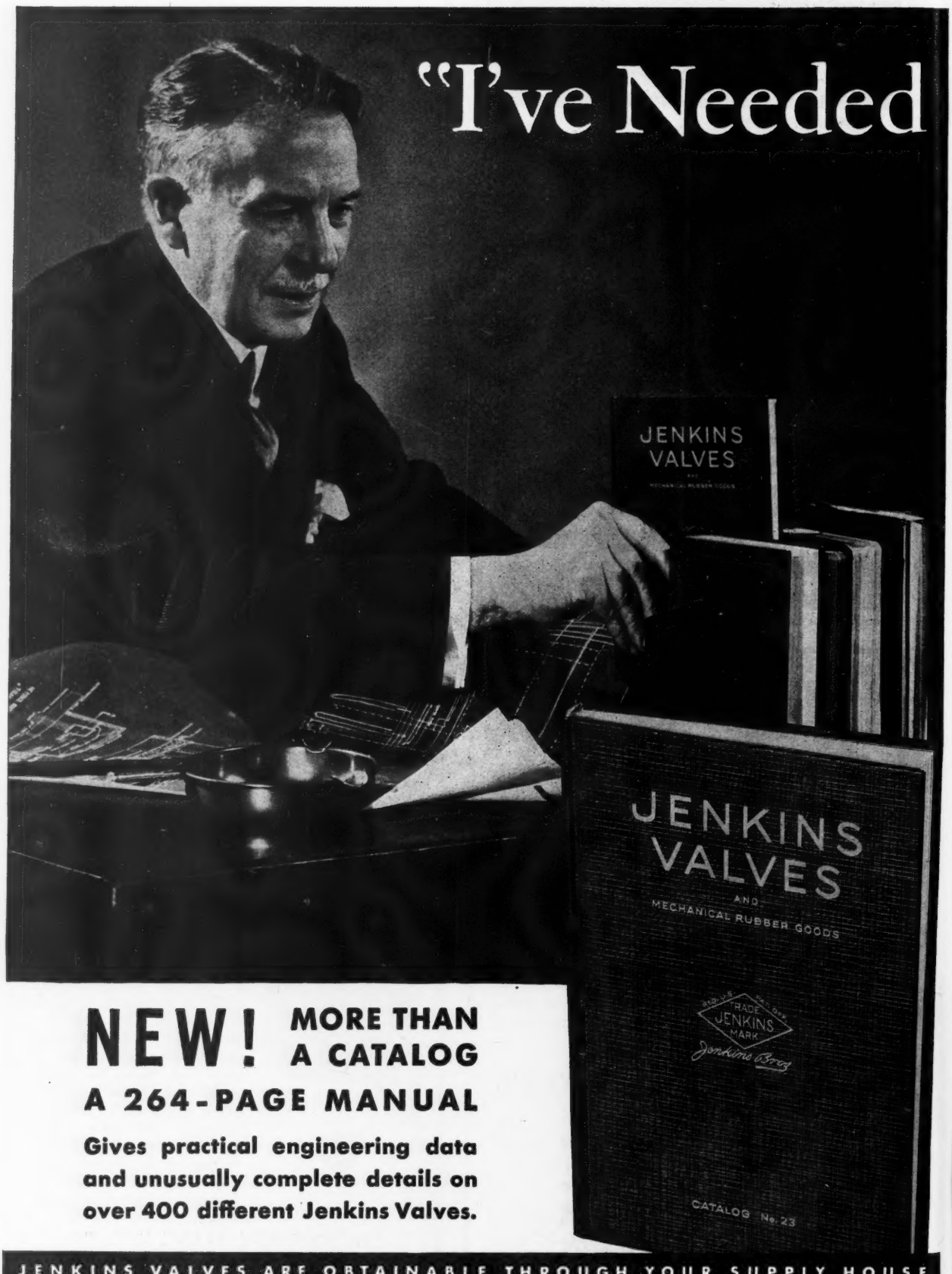
VALVES-PIPE FITTINGS-FIRE HYDRANTS

AS a thoroughly reliable gate valve for moderate steam and water pressures, you can't beat Kennedy Figure 57, the standby of thousands of engineers all over the country. Its simple, sturdy mechanism and its strong well-designed body have stood the test of time in innumerable installations. Like all Kennedy Products, these valves are generously proportioned, made of carefully selected materials, and accurately machined to assure easy installation and easy operation. Be sure to insist upon Kennedy Gate, Globe, Angle or Check Valves and Kennedy Malleable Iron, Cast Iron, or Brass Pipe Fittings. You will find them reasonably priced and thoroughly satisfactory in every respect.

THE KENNEDY VALVE MFG. CO.

Elmira, N. Y.

Warehouses and Representatives in Principal Cities



NEW! MORE THAN A CATALOG

A 264-PAGE MANUAL

Gives practical engineering data and unusually complete details on over 400 different Jenkins Valves.

JENKINS VALVES ARE OBTAINABLE THROUGH YOUR SUPPLY HOUSE

a Good Book on Valves

—and the new Jenkins Catalog is a real help in working out valve and valve layout problems"

BUSY engineers, contractors and architects by the hundreds have taken time to write in their praise for the new Jenkins Catalog. Many express the thought that this is "the first really thorough and helpful book on valves ever published". Pleasant tributes. However, it should be a good reference book. Jenkins Bros. had an exceptional knowledge of valves . . . the result of 69 years of specialized valve experience . . . to put into its 264 pages. And Jenkins spent the months of time and thousands of dollars necessary to make the book complete . . . easy to use . . . practical but authoritative.

ONE ENGINEER SAYS..

"I know of no engineering manual which gives as much practical, helpful information on valves and layouts as I find in the Data Section of this Catalog."

One of the features which keeps this new Catalog within easy reach of men who must deal with valves is the large Engineering Data Section. This part of the book actually is a well arranged, practical encyclopedia of information constantly needed. More essential data than will be found in any single engineering manual.

Equal praise, though, goes to the section on Jenkins Valves. Praise for the unusually complete description which makes it easier to pick the correct valve for a job. Praise for the improved indexing which tells at a glance where to find data on any one of *more than 400 different Jenkins Valves.*

Keep the new Jenkins Catalog handy. It will save you time and money. For any Jenkins Valve you may select is made for a lifetime of economical service...made so good that it is backed by—

A FAIR OFFER—*If you will put a Jenkins Valve to a service test on the worst place you can find, where you cannot keep other valves tight, and if it is not perfectly tight, or does not hold steam, oils, acids, water or other fluids, longer than any other valve, you may return it and your money will be refunded.*

JENKINS BROS., 80 White Street, New York, N. Y.; 510 Main Street, Bridgeport, Conn.; 524 Atlantic Avenue, Boston, Mass.; 133 North Seventh St., Philadelphia, Pa.; 822 Washington Boulevard, Chicago, Ill.; JENKINS BROS., Ltd., Montreal, Canada; London, Eng.

Jenkins Valves

BRONZE · IRON · STEEL SINCE 1864

NRA MEMBER U.S. WE DO OUR PART

A FEW OF THE HUNDREDS OF JENKINS VALVES IN THE NEW CATALOG

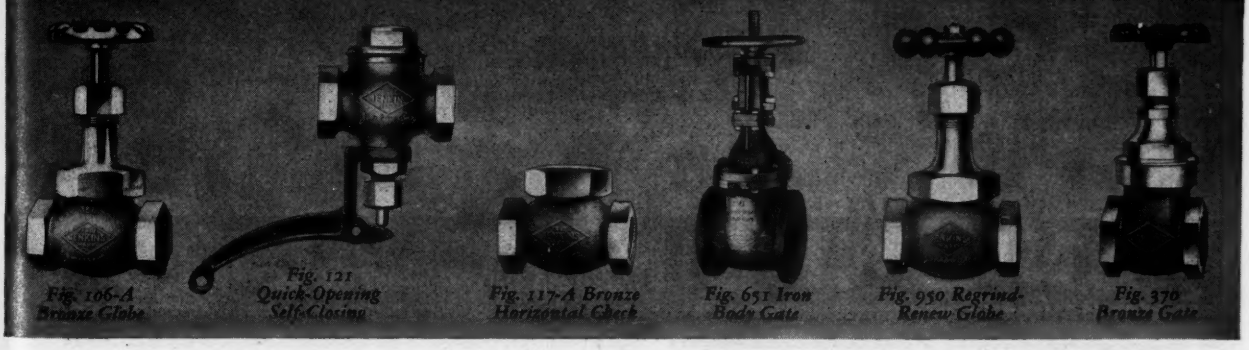


Fig. 106-A Bronze Globe — *Fig. 121 Quick-Opening Self-Closing* — *Fig. 117-A Bronze Horizontal Check* — *Fig. 651 Iron Body Gate* — *Fig. 950 Regrind-Renew Globe* — *Fig. 370 Bronze Gate*

LUNKENHEIMER

Fig. 123 "N-M-D"

(NON-METALLIC DISC)

HANDWHEEL
Deep, non-heat malleable iron wheel, easy to grip.

STUFFING BOX
Gland in all sizes, extra deep and well packed.

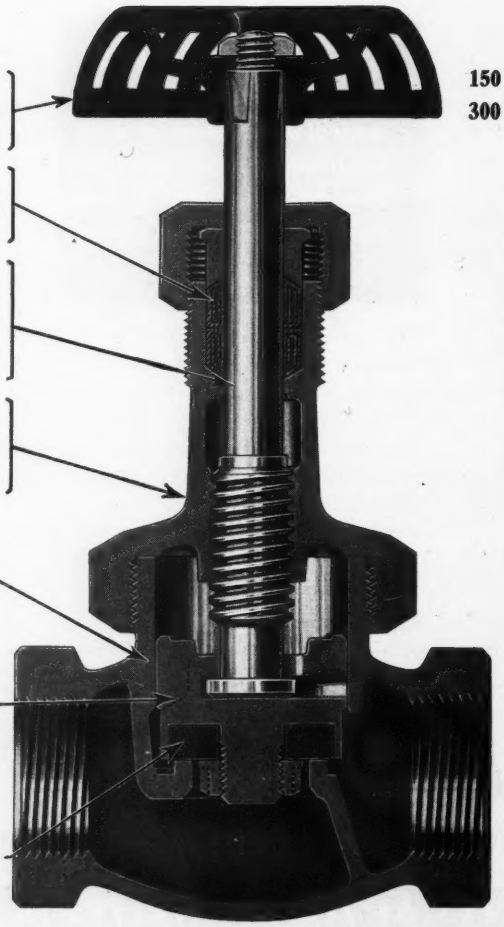
STEM
Heavy rolled bronze with long threads fully engaged. Repacking shoulder seats at stuffing box.

BONNET
One piece bonnet screws over sturdy body neck; flat face bonnet joint is easy to clean.

BODY
Substantial, well proportioned, long pipe threads, full flow areas.

DISC HOLDER
Slip-on type, extra long guides insure accurate seating. Slots for wrench hold; beveled extension to protect spud threads.

NON-METALLIC DISC
Made to Lunkenheimer standards—for maximum life. Three basic types, steam, hot water, cold water—air.



150 lb. STEAM PRESSURE
300 lb. GAS-LIQUID PRESSURE

"N-M-D" Bronze Valves are regularly available in several designs—

Globe and Angle Valves, screwed ends in sizes ⅛ to 3 inch, flanged ends ¾ to 3 inch.

Horizontal and Angle Check Valves, screwed ends in sizes ⅛ to 2 inch, flanged ends ¾ to 2 inch; with spring for compressor service ⅜ to 2 inch.

Quick Operating Valves are available in two patterns, Pull Lever ¼ to 2 inch, and Grip Lever ¼ to ½ inch.

All patterns of Lunkenheimer "N-M-D" Valves are described and listed in Booklet F. 593. Write for your copy now.

The local Lunkenheimer Distributor is prepared to supply "N-M-D" Valves.

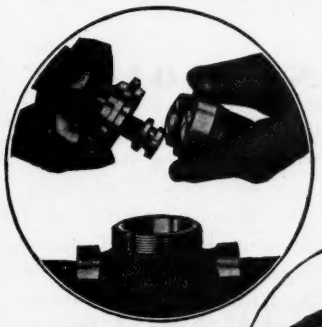
THE LUNKENHEIMER CO.
"QUALITY"
CINCINNATI, OHIO, U. S. A.
NEW YORK CHICAGO BOSTON
PHILADELPHIA SAN FRANCISCO
EXPORT DEPT 318-322 HUDSON ST., NEW YORK

LUNKENHEIMER VALVES

8-2-44

Use VULCODISC

for trouble-free valve jobs



In renewing the disc, note how easily and quickly the Vulcodisc Jiffy Disc Holder slips off the stem head. Only the disc lock nut to remove and the old disc is off and replaced in a jiffy.

Dense without being brittle—tough, yet resilient, Vulcodisc will not swell, warp or soften—in fact, its absorption is less than 1 per cent. . . That is why an old Vulcodisc comes out of the disc Holder as easily as a new one goes in. No need for hammer and chisel to cut the disc out in pieces—distoring and disfiguring the Holder.
Write for descriptive bulletin.

THE D. T. WILLIAMS VALVE CO.
Cincinnati, Ohio

EDWARD

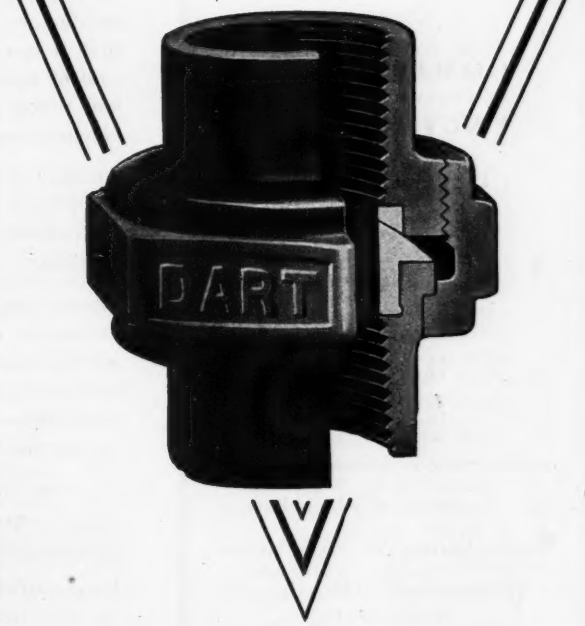
dependable
durable

BLOW-OFFS

The Edward Valve & Manufacturing Co., Inc.
EAST CHICAGO, INDIANA

Darts stay leakproof because

Both Seats Are BRONZE



NOTE the two ball-ground, wide-bearing seats shown in this sectional view of a Dart Union. These seats are not only swedged into tough malleable pipe ends, but they are both made of bronze and so will not corrode . . . That is why you can put in Dart Unions and Union Fittings, screwed or flanged, with the assurance you will commonly get double the life of leakproof service given by ordinary unions. Send today for free trial union and Dart catalog.

E. M. DART MFG. CO.
Providence, R. I.

Sales Agents: The Fairbanks Company, New York, and at all branches
Canadian Factory: Dart Union Company, Ltd., Toronto, Canada

NUMBER THREE

of A Series of Advertisements Outlining Policies of

COMBUSTION ENGINEERING COMPANY, INC.

•

Numbers One and Two of this series outlined those *sales* and *engineering* policies of Combustion Engineering which have a direct bearing on its relations with customers. This, the concluding advertisement of the series, covers similar policies with respect to *manufacturing* and *service.*

POLI

MANUFACTURING POLICY

Combustion Engineering predicates its manufacturing policy on a major conception of its business which has been stated previously in this series; namely, *that future sales depend primarily on satisfactory installations.* One of the obvious essentials of a satisfactory installation is that the equipment be so manufactured that it can be relied upon to give dependable service. In the case of equipment which is vital to the basic processes of steam and power generation, the importance of the factor of *dependableness* is self-evident.

Another essential of a satisfactory installation is that the equipment be so constructed as to assure minimum maintenance costs, not merely for a year or two but throughout its reasonable lifetime.

These considerations make apparent the logic and commercial soundness of Combustion Engineering's manufacturing policy which, briefly stated, is to turn out the best work which *exacting standards, well trained workmen, complete and modern equipment, the use of the best materials* and *adequate inspection and testing facilities* will permit.

It is one thing to state such a policy; it is quite another to be able to carry it out. Combustion Engineering has not only the purpose but also the facilities to do so.

Its manufacturing plant at Monongahela, Pa., is second to none of its class in the country. This applies to all its departments,—foundry, pattern shop, machine shop, sheet metal shop, etc. The automatic welding department at Monongahela is one of the most completely equipped of its kind. The products manufactured at this plant include all types of stokers, pulverized fuel burners, feeders, etc., air preheaters, water-wall tubes and miscellaneous castings.

The company's boiler shops at Chattanooga, Tenn., are known for the completeness and excellence of their facilities,—foundry and pattern shops, plate shop, sheet metal shop, machine shop and forge shop. Particularly notable at this plant are the specially-designed annealing furnace used in connection with welded drums and pressure vessels, the X-ray testing facilities for welded vessels and the metallurgical laboratory which is fully equipped to handle any research or test problems on base metals or alloys.

C·E

COMBUSTION

C I E S

The company's plant at Chicago is fully equipped for its specialized work of manufacturing Raymond pulverizers and milling equipment.

These manufacturing facilities permit the complete fabrication and testing of Combustion Engineering equipment under full control at all times, thus assuring the company's ability to carry out its policy.

SERVICE POLICY

It is Combustion Engineering's policy to regard *service* as involving all field work, i. e., installation of equipment, placing equipment in operation and training plant operators, and subsequent field service. These functions are carried out under the same supervision for the reason that the men responsible for installation and placing in operation are familiar with every detail of the equipment and are well qualified to do any subsequent service work that may be necessary.

Obviously, this grouping of functions requires a highly skilled and experienced field staff. Combustion Engineering service men are trained to meet this requirement and can be relied upon to exercise care and intelligence in every phase of their work. The fact that they are responsible for the satisfactory operation of a job assures their conscientious attention to the details of its installation and the training of plant operators. Their experience has taught them that proper installation and "starting up" of equipment are essential to satisfactory operating results.

All service work is done under the supervision of field superintendents who are stationed at centrally located points to assure prompt service. When unusual problems are encountered, these men may call upon special service and staff engineers who are experts in the various phases of boiler room operation.

Combustion Engineering's service policy shares with all other company policies a common purpose,—*to make every C-E installation a reference plant.*

COMBUSTION ENGINEERING COMPANY, INC.
200 Madison Avenue, New York
Canadian Associates, Combustion Engineering Corporation, Ltd., Montreal

A-107

COMBUSTION ENGINEERING PRODUCTS

BOILERS

C-E Sectional Header Boiler
C-E Box Header Boilers
C-E Bent Tube Boilers
C-E H.R.T. Boilers
C-E Electric Boilers

STOKERS

C-E Multiple Retort Stoker
Type E Underfeed Stoker
Type E Stoker-Unit (*for small boilers*)
Type H Stoker (*for industrial furnaces*)
Coxe Traveling Grate Stoker
Green Chain Grate Stoker (*natural draft*)
Green Chain Grate Stoker (*forced draft*)

PULVERIZED FUEL

Lopulco Storage System
Lopulco Direct-Fired System
Raymond Pulverizing Mills

WATER-COOLED FURNACES

C-E Water-Cooled Furnace
Lopulco Water Screen
C-E Slagging Furnace

COMPLETE UNITS

Coordinated designs comprising any combination of boiler and firing equipment and
Combustion Steam Generator (*a standard unit for medium-sized and large plants*)
C-E Steam Generator Unit (*a standard unit for small plants*)

OTHER EQUIPMENT

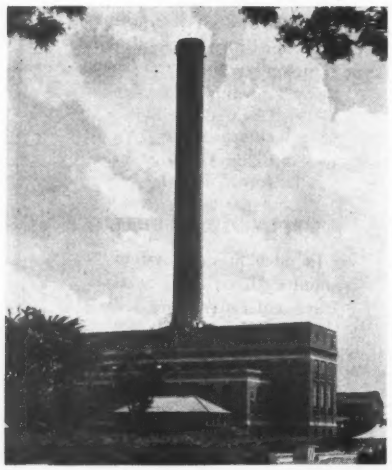
C-E Air Preheaters (*plate and tubular types*)
C-E Economizer
Quinn Oil Burners
Grieve Grates
C-E Ash Conveyors
C-E Ash Hopper

NRA

ENGINEERING

Lafayette (Ind.) and Bradford (Eng.) make profitable investments in

TAYLOR STOKERS



Purdue University Power Plant, Lafayette, Ind.

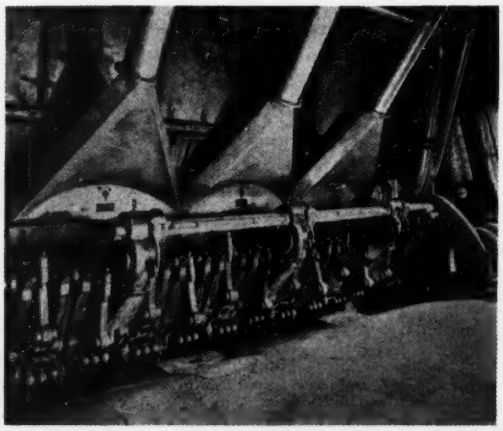
FULLY aware of the part efficient stokers can play in reducing steam costs, the leading organizations here and abroad continue to use Taylor Stokers.

For example, Purdue University, one of this country's foremost engineering colleges, recently installed Taylor Stokers in the new extension to its power plant. It was a repeat order, Taylor Stokers having been installed when this plant, which burns a great variety of Indiana coals, was built in 1925.

After a careful study of all known methods of fuel-firing, the Taylor Stoker was also chosen for Bradford, England. Here the fuels burned are mostly unwashed Yorkshire slacks, the sizing of which is such that more than 50 per cent will pass through 1/8 in. mesh. A constant supply of one type of fuel is not obtained at this station and frequently fuels from different mines are burned simultaneously and alternatively on one stoker. Since June 15 this year eight varieties of Yorkshire coal have been burned in this manner the Taylor Stoker way with entirely satisfactory results.*

You will find Taylor Stoker installations also in the boiler rooms of the Berlin (Germany) West Station, Princeton University, New York Edison Company, and many other foremost organizations the world over. Whether your plant is big or little, ask us how to get cheaper steam. We will submit detailed proof of the economies possible. No obligation.

***Information used by the courtesy of Mr. Thomas Roles, M.I.E.E., City Electrical Engineer and Manager of the Valley Road Electricity Works, Bradford, England.**



Taylor Stoker used at Bradford Power Station, Bradford, England.

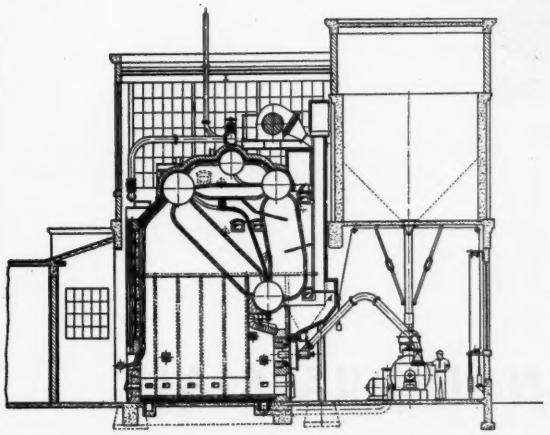
AMERICAN ENGINEERING

AMERICAN ENGINEERING COMPANY, 2408 ARAMINGO AVENUE, PHILADELPHIA

In Canada: AFFILIATED ENGINEERING CORPORATIONS, LTD., MONTREAL, P. Q.

KENNEDY PULVERIZED FUEL SYSTEM

We Designed and Installed the Complete New Boiler Plant of the Isco Chemical Company, Inc., Niagara Falls, N. Y.



More Than 90% Efficiency Maintained At High And Low Loads Over A 6 Months Period

•

Efficiencies in operation are being maintained exceeding that shown on test. This means *LOW COST OF STEAM.* May we do this for you?

Send for Our Bulletin 12-B.

Kennedy-Van Saun Mfg. & Eng. Corp.

No. 2 Park Avenue, New York City

BRANCH OFFICES:—Chicago, Ill., 120 So. La Salle St. Birmingham, Ala., Comer Bldg. Los Angeles, Calif., 416 So. Spring St. London, England, Bush House. Paris, France, 40 Rue Des Mathurins. Johannesburg, So. Africa, 73 Cullinan Bldg. Canadian Agents: The William Kennedy & Sons, Ltd., Owen Sound, Ontario. Australian Agents: Walkers, Limited, Maryborough, Queensland. New Zealand Agents: Booth, MacDonald & Co., Christchurch.

STOWE STOKERS
Compensated Feed
FOR CENTRAL STATIONS AND INDUSTRIAL PLANTS
THE JOHNSTON & JENNINGS CO.
879 Addison Rd., Cleveland, Ohio

Any

Chimney Problems?

Take advantage of the 30 years' successful experience of this company in solving your chimney problems. Our work also includes Boiler Settings, Linings for Steel Stacks, Repairs and Extensions of chimneys. No obligation for sketch and cost estimate. Write us today!

American Chimney Corporation

147 Fourth Avenue, New York, N. Y.

Boston Cleveland Philadelphia Chicago Detroit

1877

WHAT MAKES AN INDUSTRIAL ORGANIZATION LIVE?

It doesn't just happen. A company does not continue in the business of building boilers, or any other product, for fifty-six years just by accident.

Dotting the path of progress in boiler design are many Edge Moor milestones—proof of inherent leadership in engineering thought and initiative.

★ The first successful waste heat installation in a cement plant was made by Edge Moor. Today, approximately eighty percent of the world's cement plant waste heat boilers are Edge Moor's.

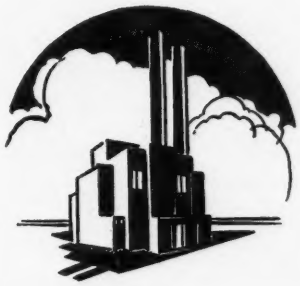
★ The first pulverized fuel fired boilers for a public utility were designed and installed by Edge Moor.

★ Edge Moor built the first longitudinal boiler with more than two drums, a design soon widely adopted after Edge Moor initiative overcame engineering prejudice.

★ Edge Moor was the father of the single pass boiler and many another first quality pioneer engineering achievement that has since come into general use in the steam generating field.

Back of the Edge Moor Organization are many men's personalities, their whole business lives devoted to making boilers better and building an unimpeachable record for the highest quality and nothing but the best in workmanship and materials.

Today, Edge Moor perpetuates its reputation as a front-rank performer with an organization sensitively attuned to the power requirements of the new era and under the personal supervision of Mr. Ely C. Hutchinson, one of the recognized authorities of our times on trends in modern power development and their economic significance.



1934

THE MODERN EDGE MOOR ★ ★ ★ ★

To all those who value modern qualifications for engineering, building and erecting steam generating equipment, custom built to the particular requirements of each individual power problem—and who respect a company which stands four-square behind its products—Edge Moor, today, offers:

★ Outstanding progressiveness of thought applied with discriminating conservatism.

★ Four acres of fully modernized shops employing advanced equipment and technique for metallurgical research—for the welding of boiler drums and other pressure vessels of steel, chrome and alloyed metals—for X-ray inspection of welds, with equipment capable of looking through 4¼ inches of metal.

★ A wide range of types and sizes of Water Tube Boilers from which a selection or adaptation may be made to suit almost any given set of conditions.

★ An engineering department ready to assist in analyzing special problems—to work with purchaser's engineers for best results.

★ Auxiliary equipment of this company's design and manufacture embracing water walls, air preheaters, superheaters and economizers engineered to assure high overall efficiency of every Edge Moor installation, offering centralized responsibility for all units comprising the complete steam generator.

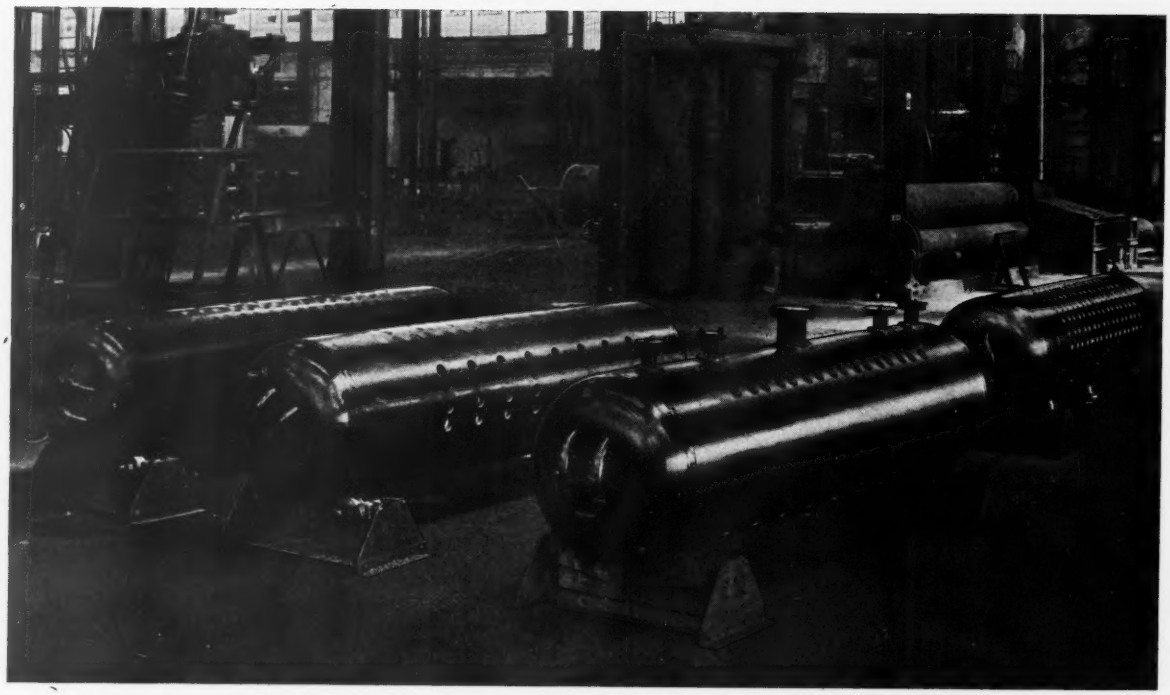
★ Dependability of service, stability of organization and—

★ Pride of product that considers Edge Moor's reputation on a par with their desire for business.

EDGE MOOR IRON COMPANY

EDGE MOOR, DELAWARE

Builders of all types of Water Tube Boilers and their Auxiliaries . . . Edge Moor-Irwin Gas Fired Boilers . . . Class I—II or III Welded Pressure Vessels of Steel, Chrome and other Alloyed Metals.



HOMOWELD Boiler Drums!

The fusion welded boiler drums shown above, designed to operate at 400# working pressure, are installed in a Kansas Municipal Power Plant.

The HOMOWELD, a Vogt development resulting from years of research, is not to be confused with ordinary electric welding. It exceeds all physical and chemical requirements of the A. S. M. E. Code and homowelded vessels become in effect seamless steel units.

VOGT Water Tube Boilers, with HOMOWELD Drums, may be had in various types and sizes to meet every requirement for dependable and economical steam generation.

New York
Chicago
Cleveland
Philadelphia
Dallas

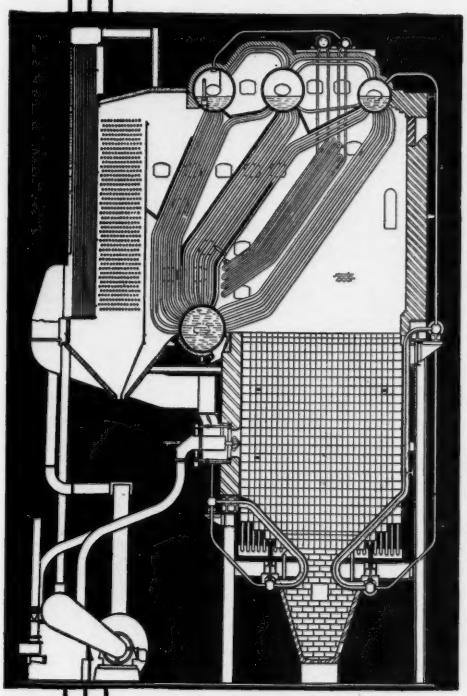
Manufacturers of: Water Tube Boilers, Ice Making and Refrigerating Machinery, Drop Forged Steel Valves and Fittings, Oil Refinery Equipment, Heat Exchangers.

HENRY VOGT MACHINE CO.
INCORPORATED
LOUISVILLE, KY.

Vogt

Water Tube Boilers

Babcock & Wilcox Boiler Units Are Complete in Responsibility



Stirling Boiler complete with Babcock & Wilcox Superheater, Return-Bend Economizer, Air Heater, Bailey Water-Cooled Hopper-Bottom Furnace, and B & W Coal-Pulverizing and Burning Equipment.

Since the year of its incorporation, 1881, The Babcock & Wilcox Company has continuously progressed despite the business depressions that have affected the nation. This has been made possible through prudent management that conserved resources during prosperous years. Today, as a result of the same careful policies, the Company remains financially sound and free of bonded indebtedness.

The Company also enjoys a reputation for quality of product and fair dealing that is a continuing responsibility—a reminder that the Company must never lower the standards that have won it recognition and must ceaselessly strive for still higher standards.

This incentive of responsibility is, in the case of Babcock & Wilcox, reflected in the continuation of research work on problems relating to the generation of steam and of development work on new products — operations that could be carried on, during the past several years, only by a company such as Babcock & Wilcox.

Recognition of the responsibility and soundness of the Company is evident in the award to it of contracts for much of the major equipment for the largest power houses and in the $10,908,000 contract for the gigantic welded pipes to be installed at Boulder Dam.

Babcock & Wilcox Products always have been and always will be reliable—engineered with unsurpassed skill—built with great care—with every claim made for them substantiated—and sold at a fair price—moderate in comparison with their quality.

BABCOCK & WILCOX BOILER UNITS are complete in every important respect:

Boilers
Component Equipment
Experience
Responsibility
Engineering Leadership
Service
Organization and Facilities

The Babcock & Wilcox Company...85 Liberty St....New York

G-38

BABCOCK & WILCOX

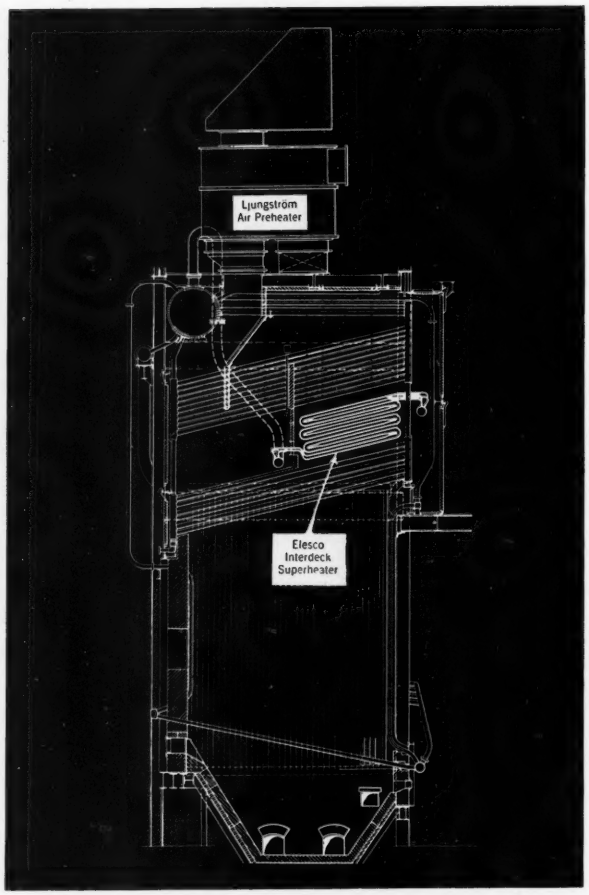
ELESCO SUPERHEATERS
LJUNGSTRÖM AIR PREHEATERS

in Lincoln Power Plant
of the
Boston Elevated Railway

This completely reconstructed plant, placed in operation during 1932, is representative of the latest power plant practice. It was designed especially for high efficiency with a high factor of availability; consequently important to its operation are the Elesco superheaters and Ljungstrom air preheaters, providing steam at higher pressure and temperature, and highly-preheated combustion air.

■ ■ ■

Both Elesco superheaters and Ljungstrom air preheaters embody the cumulative engineering and performance experience obtained from all types of steam power plants. Applicable to new or existing plants, they assure the utmost performance efficiency obtainable under the plant operating conditions.



Four 1148-hp. C-E sectional header (Walsh-Weidner type) boilers, pulverized coal fired, equipped with Elesco interdeck superheaters and Ljungstrom independent-fan type air preheaters for the following conditions:

Steam temperature	750 deg. F.
(Superheat	290 deg. F.)
Pressure	450 lb. per sq. in.
Evaporation	152,000 lb. steam per hr., from and at 212 deg. F.
Exit gas temperature	280 deg. F.
Preheated air temperature	550 deg. F.

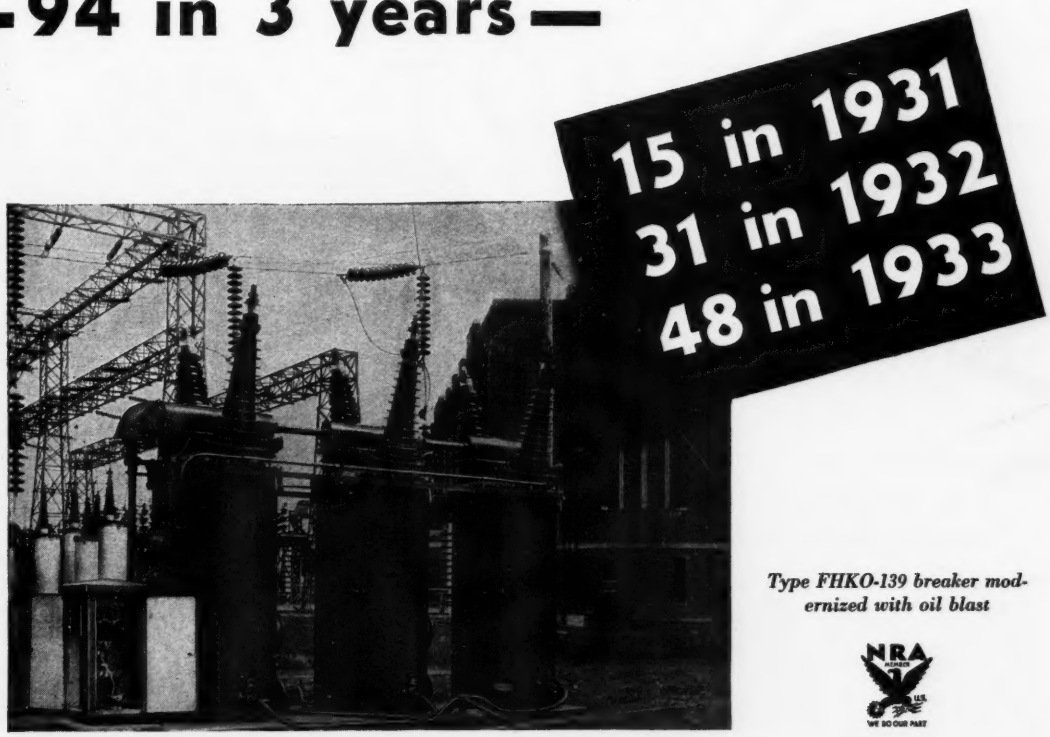
THE SUPERHEATER COMPANY
THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York

Representatives in all large industrial centers

Another Company Modernizes Breakers with OIL BLAST

—94 in 3 years—



Type FHKO-139 breaker modernized with oil blast

Performance Counts. This is again evidenced by the fact that one of the large power companies has modernized an increasing number of breakers since 1931. During the last three years, 94 "FHK" outdoor-type G-E breakers, of various voltages, have been modernized and improved by the addition of oil blast.

The engineers of that company have found that oil blast assures better performance and higher speed of circuit interruption. Each year the success of these modernized breakers added further evidence of the effectiveness of oil blast.

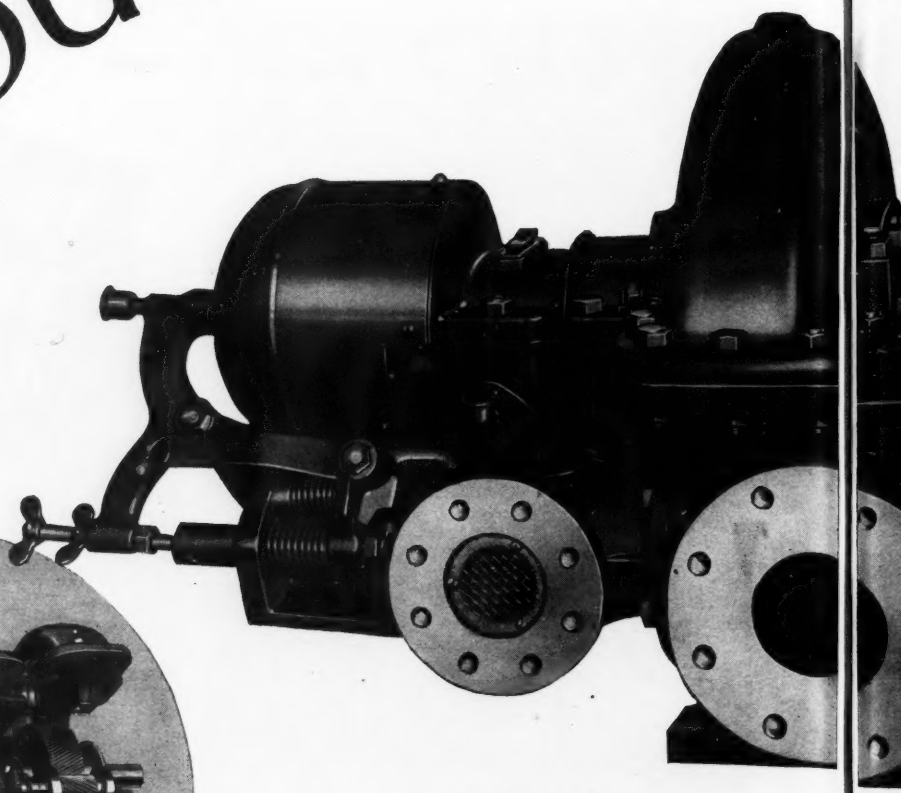
You, too, can modernize your G-E breakers —quickly, easily, and economically. The addition of oil blast will result in greater interrupting ability; decreased maintenance; greater security; better service; and the rapid clearing of faults, which is one of the important factors in stabilizing a system.

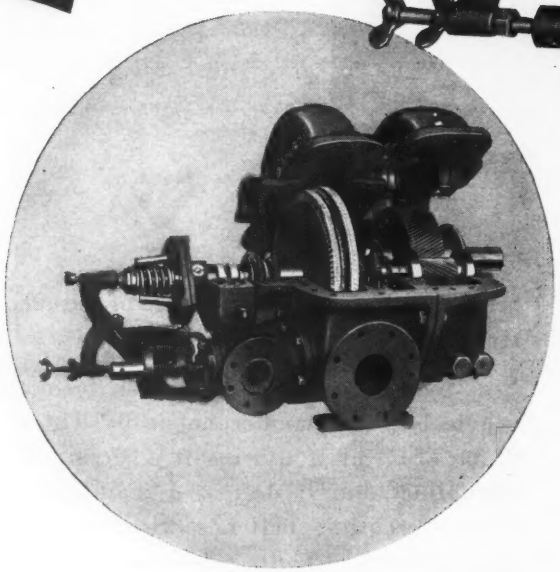
Send for detailed information which will explain how you can modernize the G-E breakers on your system. General Electric, Schenectady, N. Y.

470-42

GENERAL ELECTRIC

INTRODUCING *the*





FEATURES

COMPACTNESS — Requires only slightly more space than a standard mechanical-drive turbine.

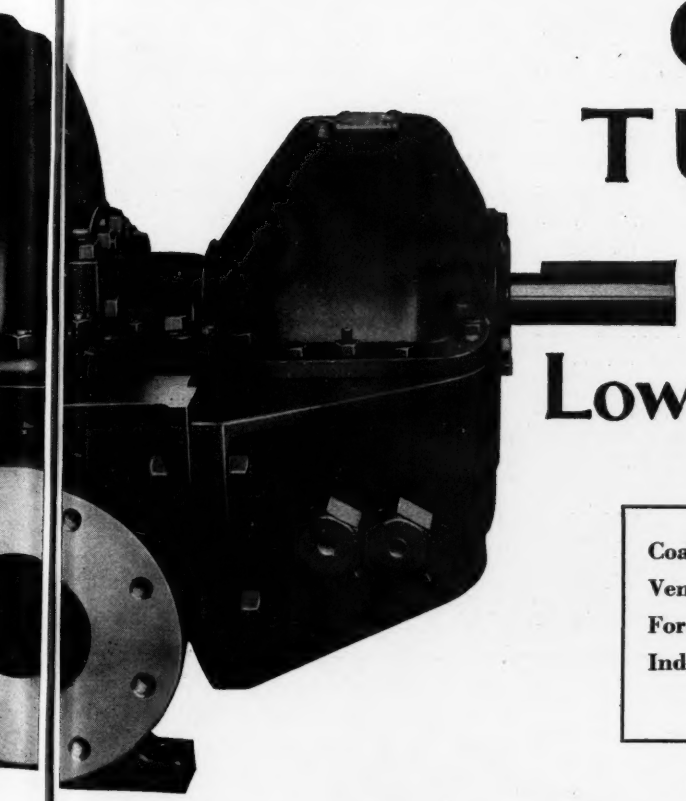
SIMPLE ASSEMBLY — One self-contained, close-coupled unit, easily mounted and aligned. Horizontally split casings permit the removal of either the low- or the high-speed rotor without disturbing the other.

RELIABILITY — Gear and turbine designed as a unit, providing permanent gear alignment. Enclosed gears, running in oil, carry rated turbine output with ample factor of safety.

ECONOMY — Has no excess parts. Units run at high over-all efficiency. Initial, installation, maintenance, and replacement costs are small.

NRA MEMBER U.S. WE DO OUR PART

NEW G-E GEAR-TURBINE *for* Low-speed Drives



Coal pulverizers	Paper machines
Ventilating fans	Slow-speed pumps
Forced-draft fans	Stokers
Induced-draft fans	Compressors
Conveyors	

The new G-E gear-turbine combines, in a single unit, a standard mechanical-drive turbine and a sturdy reduction gear. It is a self-contained unit for drives that require speeds lower than those normally obtainable with ordinary turbines. A complete line of these sets, ranging from 5 to 150 hp., with speed ratios as high as 12 to 1, is available.

Our turbine specialists will gladly explain the advantages of gear-turbines and assist you in selecting the proper units to meet your requirements. Also, we can supply you with single- and multi-stage mechanical-drive turbines in ratings from 5 to 600 hp., and gear-motors in standard ratings from 1/6 to 75 hp.

Refer your problems, or send your requests for further information, to the nearest G-E sales office or to General Electric, Schenectady, N. Y.

175-64

GENERAL ELECTRIC

ALPHABETICAL INDEX TO ADVERTISERS

Air Preheater Corp., The..... 88
Allis-Chalmers Mfg. Co..... 20
American Chimney Corp..... 83
American Engineering Co..... 82
Armstrong Machine Works... 9
Atlas Valve Co..... 11

Babcock & Wilcox Co..... 87
Babbitt Steam Specialty Co., Inc. 75
Bailey Meter Co..... 13
Brassert & Co., H. A..... 11
Brown Instrument Co., The... 12
Burt Mfg. Co. 10

Chaplin-Fulton Mfg. Co., The.. 11
Combustion Engineering Co..80-81

Dart Mfg. Co., E. M..... 79
Dearborn Chemical Co..... 73
Defender Auto. Regulator Co.. 12
De Laval Steam Turbine Co...
.....Inside Back Cover
Detroit Stoker Co..... 83

Eagle-Picher Lead Co..... 69
Edge Moor Iron Co.....84-85
Edward Valve & Mfg. Co., Inc. 79
Elliott Co. 3

Fisher Governor Co..... 13

General Electric Co.....89, 90, 91
Graver Tank & Mfg. Corp..... 75

Hercules Float Wks..... 10

International Nickel Co..... 6

Jenkins Bros. 76-77
Johnston & Jennings Co..... 83

Kennedy Valve Mfg. Co., The. 75
Kennedy-Van Saun Mfg. &
Eng. Corp. 83

Lonergan Co., J. E..... 12
Lunkenheimer Co., The..... 78

Manzel Bros. Co..... 10
Moore Steam Turbine Corp....
..... Back Cover

National Aluminate Corp..... 18
Nicholson & Co., W. H..... 10

Permutit Co. 19
Pierce Co., The Wm. B..... 92

Republic Flow Meters Co..... 15
Roto Co., The..... 92

Sarco Co., Inc. 10
Scaife & Sons Co., Wm. B..... 13
Signboard Section 72
Simplex Valve & Meter Co..... 12
Smooth-On Mfg. Co..... 11
Socony-Vacuum Corp. 7
Squires Co., The C. E..... 8
Standard Oil Co. (Indiana)..16-17
Superheater Co., The 88
Swartout Co., The..... 12

Taylor Inst. Cos. 14
Terry Steam Turbine Co.....
.....Inside Front Cover
Texas Co. 71

United States Rubber Co.....4-5

Viking Pump Co..... 75
Vogt Machine Co., Henry..... 86

Wickes Boiler Co..... 83
Williams Valve Co., The D. T.. 79

Yarnall-Waring Co. 67-68

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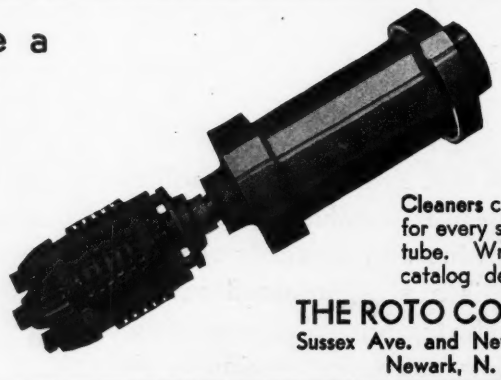

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